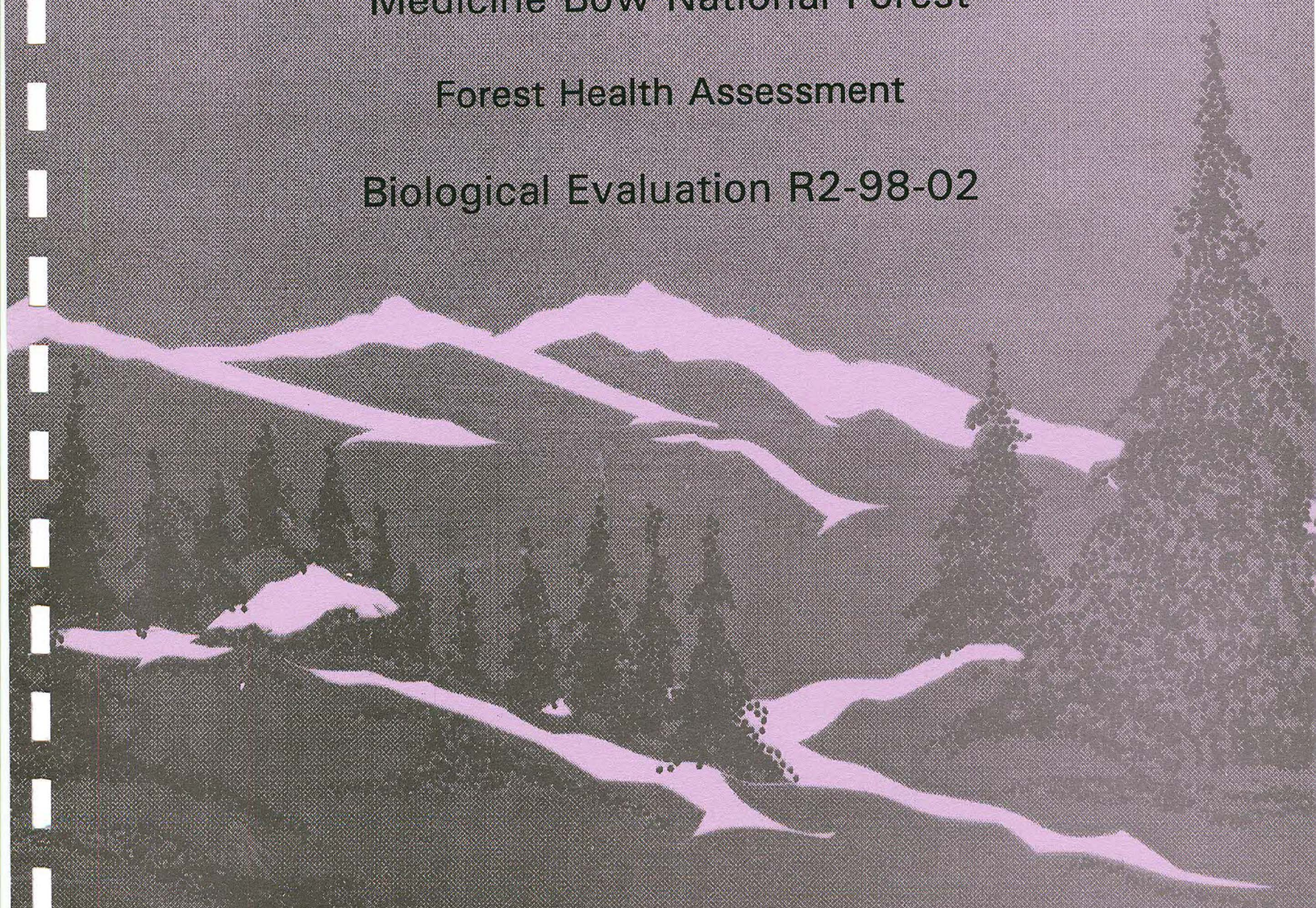
Forest Health Management

Cold Springs Analysis Area
Douglas Ranger District
Medicine Bow National Forest

Forest Health Assessment

Biological Evaluation R2-98-02



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BIOLOGICAL EVALUATION
R2-98-02

COLD SPRINGS ANALYSIS AREA
DOUGLAS RANGER DISTRICT
MEDICINE BOW NATIONAL FOREST

FOREST HEALTH ASSESSMENT

December 1997

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EXECUTIVE SUMMARY

COLD SPRINGS ANALYSIS AREA
DOUGLAS RANGER DISTRICT
MEDICINE BOW NATIONAL FOREST
FOREST HEALTH ASSESSMENT

In response to a continuing need to develop a multi-resource, multi-agency approach to improvement in the forest health of the Medicine Bow National Forest in Wyoming, the forest health of the Cold Springs Analysis Area within the Douglas Ranger District was examined. Because of the history of mountain pine beetle *(Dendroctonus ponderosae)* activity and lodgepole pine dwarf mistletoe (*Arceuthobium americanum*) infestation in the lodgepole pine cover type, that forest component was chosen for detailed evaluation.

During 1994, 1995 and 1996, stand exam surveys were conducted in National Forest System-administered forested lands within the Analysis Area. Data from the stand examinations, together with information gleaned from computer projections of future insect and disease trends, have been incorporated into this document which covers the biology of the major pests, addresses their impacts on the Analysis Area, and presents a number of management options to mitigate their effects.

Through this analysis, the following conclusions were reached:

o The potential impacts of insects and diseases should be considered in all management decisions that are made in the Analysis Area.

o Currently, most major forest vegetation types in the Analysis Area differ markedly in structure from the desired forest condition as defined in the Medicine Bow National Forest Plan dated 1985. Most of these vegetation types have more than 86% of their structural stages in mature/overmature classes which are conducive to outbreaks of most of the important insect and disease agents. This situation has largely resulted from fire suppression and other management practices in short-interval, fire-adapted ecosystems that have been conducted on the Forest for most of the century, interrupting the natural disturbance regime which helps maintain ecosystem health. Without widespread implementation of corrective treatments, unnaturally severe fires and major insect and disease epidemics are almost certain to occur.

o The Analysis Area is susceptible to a substantial mountain pine beetle outbreak. Approximately 51% of the lodgepole pine stands inventoried would be expected to sustain moderate to high levels of mortality (i.e. risk classes) should a beetle outbreak occur. Although mountain pine beetle outbreaks are a natural component of vast unmanaged forests, the goal for the managed forests is a reduction in the amount of highly susceptible stands. Most of the stands in moderate to high-risk classes have age and structural characteristics highly conducive to bark beetle attack. Elevation was most responsible for differentiating between the moderate and high-risk stands.

o Because of the recurring, cyclical nature of mountain pine beetle outbreaks, it is not a matter of if a major outbreak will occur, but when it will occur. Lowering tree density and diameter over large areas is the only feasible way to reduce the beetle risk. Recommended treatments include clearcutting, selective thinnings and the use of prescribed fire. Specific treatment strategies will need to be chosen for each site based on current condition.

o Lodgepole pine dwarf mistletoe is widespread throughout the Analysis Area. More than 68% of the stands inventoried are infested. Many stands should probably be scheduled for treatment. Patch cutting, clearcutting, shelterwood or seed tree cutting remain the only viable treatment alternatives where average stand dwarf mistletoe ratings (DMRs) are moderate to high. Below this level, sanitation thinning may be considered. Controlled burning may also be used to sanitize stands, but any residual infected trees left after the burn must be removed in a timely manner. The particular treatment applied must be determined on a case-by-case basis, according to the individual stand conditions and the intensity and distribution of the dwarf mistletoe infestation (DMI).

o Approximately 77% of the acres have both dwarf mistletoe (low, moderate or high levels) and mountain pine beetle (low, moderate to high risk levels) management concerns. DMI ratings are moderate to high in only 19% of the acres. Because bark beetle risk may be elevated in mistletoe-infested stands, treatment of moderate to high MPB risk stands with dwarf mistletoe is a higher priority than treatment of similar stands without mistletoe. In many of these areas, treatments aimed at reducing bark beetle risk and measures to mitigate the effects of dwarf mistletoe may be combined into a single integrated treatment.

o Comandra blister rust was present in 36% of the stands inventoried. While the majority of the stands were only lightly infected (based on percent of live trees per acre with stem rust), those stands with greater than 10% of the stems infected should be considered for treatment, as well as those stands with moderate to high levels of dwarf mistletoe and moderate to high mountain pine beetle risk.

o In general, silvicultural and prescribed fire treatments, applied on a widespread scale, will provide the most durable, long-lasting solution to undesirable forest health situations in the Cold Springs Analysis Area. The available treatment options summarized above are discussed in detail in this evaluation. The relative effectiveness of these options are summarized in Table 12.

o Prioritization of areas for treatment must take into account the insect and disease conditions of individual stands. Treatment of groups of stands may be integrated at appropriate watershed or landscape levels. Highest treatment priority should be given to stands with the highest levels of mountain pine beetle risk and/or dwarf mistletoe incidence and severity ratings. Treatment of moderate-to-high mountain pine beetle risk stands that contain dwarf mistletoe should receive higher priority than similar stands without mistletoe. Proximity to high value areas, such as campgrounds, recreation areas, or important viewsheds should also be used to determine treatment priority.

o Because of the difficulty in treating large areas and the need to consider other factors which restrict forest management activities, we will likely have to accept many of the changes that will occur across most areas of the Analysis Area. Small-scale disturbance events may result in greater floristic and faunal diversity and may aid in achieving long term forest management goals, whereas large-scale catastrophic events may be unacceptable. While management efforts must be directed toward the avoidance of these catastrophic events, opportunities to improve the health of the forest

should be taken wherever possible. Plans for landscape-scale treatment should be developed and implemented as soon as possible.

o The conditions encountered at the Cold Springs Analysis Area are by no means unique. Similar conditions are common throughout the lodgepole pine cover type on the Medicine Bow National Forest and on other forests throughout the Rocky Mountain Region. The recommendations given and conclusions reached in this evaluation may be applied to many similar areas.

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A. Introduction and Objectives

The Medicine Bow National Forest includes more than 850,000 acres of forested lands in Wyoming. The forests that we see today have been shaped over the millenia by natural events including fire, insects and disease. In the past few thousand years, native Americans used fire to clear areas for game. However, their impact is not as obvious as that of modern society. In more recent history, mining, harvesting and settlement have impacted the forest.

Inventories show that the lodgepole pine *(Pinus contorta*) forest type is the most common on the Forest, followed by Engelmann spruce/subalpine fir (*Picea engelmannii/Abies lasiocarpa*), ponderosa pine (*Pinus ponderosa*), aspen (*Populus tremuloides*), and Douglas-fir (*Pseudotsuga menziesii)* (Table 1). Most of these stands are mature to overmature. In fact, about 75 percent of the stands are in this condition (Table 1). With the majority of the forested lands in a mature to overmature condition, fire, insects and disease will play significant roles in near term succession and disturbance processes.

Lodgepole pine grows in extensive pure and mixed stands within the Analysis Area. Lodgepole pine is considered a seral species, yet it dominates large areas throughout the Rocky Mountain Region. An important component of the lodgepole pine ecosystem are the "change agents" of fire, insects and disease, which periodically revert stands to an earlier seral stage and allow the continued predominance of lodgepole pine.

The area selected for analysis encompasses several thousand acres, for which stand exam data exists and vegetation management treatments have been conducted. The Cold Springs area encompasses four watersheds, totalling more than 63,000 acres. This area is located approximately 32 miles southwest of Douglas, Wyoming in Converse and Albany counties (see Figures 1-2). The ownership is 39% NFS (24,775 acres), 1% BLM (650 acres), 9% State of Wyoming (5,790 acres), and 51% private/other (31,965 acres) (Figure 3).

According to the Medicine Bow National Forest Plan, dated October 1985, the goals for the area are to manage for a mix of semi-primitive motorized recreation opportunities as well as provide for livestock grazing, winter range for big game, and timber products. Potential vegetation treatments of the forested area include, but are not limited to, clearcutting, shelterwood, and selection harvests. The forest health of the area is declared to be a major concern.

Approximately 74 percent of the NFS lands are classified as lodgepole pine type (15,936 acres) and a detailed analysis was concentrated on that component. Stand inventories were conducted from 1994-1996, with funding from the Forest Health Management Staff, Rocky Mountain Region. The

inventory included over 8,800 acres in the lodgepole pine cover type, which were used in the analysis. In addition, the inventory data for state and private lands that included 14,461 acres in lodgepole pine type are summarized.

B. Ecology of the Major Forest Insects and Diseases on the Medicine Bow National Forest

Of the numerous insects and diseases that affect this forest, only a few have had a significant impact on the attainment of forest management objectives. These will be discussed in detail.

Major infestations of mountain pine beetle *(Dendroctonus ponderosae)* have caused mortality over large areas of the Forest in the past and continue to play a role in forest succession. The most important diseases are caused by the dwarf mistletoes *(Arceuthobium spp.)*, and comandra blister rust *(Cronartium comandrae)*. This analysis will focus on the role of these organisms in the forest.

Mountain Pine Beetle

The mountain pine beetle (MPB) is a native, tree-killing bark beetle that has a persistent outbreak history in ponderosa pine along the Laramie Peak Range and in the mature and overmature lodgepole pine stands of the Medicine Bow National Forest. The large-scale mountain pine beetle epidemics of the 1970's and 1980's provide an example of natural forces causing large scale changes in spacing and structural classes of tree species and accumulations of dead biomass. Most epidemics develop because there are large areas of unmanaged lodgepole pine forests (McGregor et al., 1985).

The MPB usually infests and kills standing live trees larger than eight inches in diameter but may attack smaller trees when intermixed with the larger trees. During epidemics, trees are usually killed in small groups of 3-10 trees but such groups may coalesce into one large group of more than 100 dead trees. Low level or endemic MPB populations are usually associated with single trees which are diseased or stressed by any number of agents or causes. The expected level of mortality (i.e. risk) in lodgepole pine stands from the beetle can be estimated by average tree diameter, average tree age, and location by elevation and latitude (Amman et al., 1977).

In order to be susceptible to a beetle epidemic, a lodgepole pine stand must be located at an elevation and latitude where climate is favorable to the beetle. In general, to sustain a heavy MPB infestation, stand age must be 80 years or more, and the average diameter at breast height (dbh) of a stand for trees 5 inches and larger must exceed 8 inches. By multiplying the risk factors (1=low; 2=moderate; 3=high) for elevation and latitude, average age, and average dbh., the stand's expected level of mortality or risk classification is obtained; low=1-9; moderate=12-18; high=27. A general model for determining if a stand lies within a zone of potentially heavy, moderate, or light beetle infestation is presented by Amman et al. (1977). This scheme is presented as follows:

Elevation (feet)1/	Average age (years)	Average d.b.h. (inches)
> 9,200 (1)	<60 (1)	<7 (1)
8,200-9,200 (2)	60-80 (2)	7-8 (2)
< 8,200 (3)	>80 (3)	> 8 (3)

1/ Elevational risk values vary according to latitude. Values given are for the northern half of the Medicine Bow National Forest at 42.5 degrees north latitude.

Two of the factors utilized to predict stand susceptibility to mountain pine beetle mortality, average stand age and average d.b.h., increase with time, thus increasing susceptibility. As a result, if management activities or natural disturbance does not alter average stand age and average diameter, stand susceptibility inevitably increases. On the Medicine Bow National Forest, fire exclusion has altered stand conditions to favor outbreaks of the beetle. However, mountain pine beetle populations are currently at low level or endemic status in the general area.

The MPB influences stand structure in pure pine stands. The MBP kills greater portions of large diameter trees, so the average stand diameter is lowered during epidemics. Depending on the extent of the tree killing within the stand, small to large openings may be created in the canopy. Under extreme epidemics, entire stands may be killed so the site is thus converted to a younger age class of pine or to another seral stage.

MPB epidemics also influence herbage production, wildlife populations, and fire hazard. The growth of forbs and grasses increases in beetle-killed areas. Wild ungulates may benefit from the increased herbaceous production and the standing beetle-killed trees may provide habitat for cavity nesting birds. In general, the influence of MPB epidemics will vary depending on the needs of the particular species. Fire hazard is increased for several years following MBP mortality due to the dead needles remaining on the trees and the probability of higher intensity fires may be increased for a number of years as the dead trees fall to the ground and add to the surface fuel loading.

The frequency of MPB epidemics of a given area may range from 20-40 years depending how rapidly some trees grow into large diameter categories. However, for a given stand, the frequency between epidemics may range from 50-100 years depending on how much of the original stand was killed.

The MPB is a natural and integral part of the lodgepole pine ecosystem. However, changes in stand conditions caused primarily by fire exclusion may have altered landscape conditions to favor more and larger outbreaks of the beetle. Beetle populations may respond to favorable conditions (climate, host conditions, etc.) in a dramatically sudden way; an outbreak of MPB can be astonishing in its rate of increase.

Although stands may be rated as having a high susceptibility to mortality from MPB, it is almost impossible to predict exactly when an outbreak will occur. Conditions may become favorable to the beetles next year or within the next decade; onset of an outbreak appears to be highly random. There is no treatment available that can be expected to halt an area-wide MPB outbreak once it begins. For this reason, manipulating stand conditions to resist beetle attack before an epidemic occurs is a highly efficient means of management.

Lodgepole Pine Dwarf Mistletoe

The dwarf mistletoes are parasitic seed plants that affect most conifers in the western United States. Dwarf mistletoes and western conifers began evolving together about 25 million years ago. Today, the dwarf mistletoes are one of the most widespread and damaging groups of forest diseases in the West. Fires normally change forest composition and sanitize infested stands by killing the parasite when the host tree is killed. The new replacement forests are essentially free of mistletoes where large fires occur. Thus, almost half a century of fire suppression of large fires has also played a critical role in shaping these forests.

In the absence of fire and management, however, the status of dwarf mistletoes does not change markedly from year to year. Mistletoes spread slowly, at a rate that averages one to two feet per year in even-aged stands. Past management practices have, in some situations, increased the rate of spread of the disease by the perpetuation of unevenaged stand conditions that accentuate the spread of dwarf mistletoe from overstory to understory trees. The incomplete removal of infected trees, which are usually non-merchantable, in timber sale areas has led to increased spread of the disease. The retention of infected trees along visual corridors and for wildlife habitat has resulted in subsequent spread to adjacent uninfested stands. The limitation on the size of harvest units in recent years has also had an impact. It is most effective to cut all infected trees in stands of at least 20 acres in extent to minimize reinfection from the edges of the stand. Small harvest units can aggravate and intensify the rate of infection. The lack of markets for smaller trees that occur in heavily infested, low volume stands has also prevented treatment of many diseased stands.

Silvicultural practices to control dwarf mistletoes have been advocated since the early part of the century; however, these efforts were limited to removing only the large, merchantable overstory trees during the course of harvesting operations. This type of partial cutting actually increased the amount of infection in residual stands. Leaving infected trees of no commercial value in regeneration areas also intensified the problem.

Forest roads and timber markets began improving in the 1950's. Improved access and markets, coupled with more specific guidelines from research, made it possible for managers to take more effective action against the dwarf mistletoes.

In the past two decades, dwarf mistletoe control programs have been more consistent. In addition, thousands of acres are treated each year through scheduled stand improvement and timber harvesting operations. Despite these efforts, our ability to substantially improve the health of the forest is limited by markets and politics.

Impacts of dwarf mistletoe on the resource

The most important effect of dwarf mistletoes is timber volume reduction. When trees are heavily infested, dwarf mistletoes reduce both height and diameter growth and increase mortality. The extent of loss depends upon several factors including host and mistletoe species, intensity of infection, site index, stand density and stand structure. Infestation levels vary greatly from stand to stand dependent primarily upon fire history of the stand and past management practices. Significant reduction in yields of stands occurs if they are infected early in their development and if no suppression measures are taken to reduce spread and intensity of the disease.

The first symptom of infection on an individual tree is a swelling of host tissues. Later, the swellings enlarge and produce dense masses of distorted branches called witches' brooms. As the parasite spreads through the tree crown, tree growth is gradually reduced. Eventually the top weakens and dies, diameter growth ceases, and the entire tree dies. Insects, particularly bark beetles, may cause an earlier death by attacking weakened, heavily infected trees (Johnson et al., 1976). Other pests, such as decay fungi, enter wounds and swellings created by the mistletoes.

Dwarf mistletoes not only cause losses in timber values, but also adversely affect recreation values by killing trees in campgrounds, picnic areas, etc. In addition, the decay and canker fungi associated with dwarf mistletoe infections kill or weaken branches so that they are more susceptible to wind breakage, thus increasing the hazard to recreationists. Heavily infested stands with large mistletoe brooms increase ladder fuels and the probability of crown fires as well. There is also a large component of dying and dead trees that contribute to the overall fire hazard.

Although the debilitating effects of the mistletoes on tree growth and forest productivity are well documented, their effects on non-commodity forest values have not been fully assessed. The effects on wildlife, for example, may be positive or negative depending upon the particular ecological needs of the wildlife species. Dead trees provide nesting sites for snag-dependent bird species. Witches' brooms also provide cover and nesting sites for many birds and mammals. Large areas infested with mistletoes have a more irregular, open forest canopy, favoring certain bird and mammal species. As the openings regenerate to either the same tree species or other tree species and brush, greater vegetation diversity will occur. This results in profound changes in both stand structure and species composition. The mistletoe plants themselves provide a food source for some mammals, birds and insects.

The impacts of dwarf mistletoes on visual quality would generally be considered negative through reduced tree vigor, increased mortality, and increased fuel accumulations and susceptibility to fire. Effects on other resource values are, for the most part, unknown.

Forest-wide surveys conducted in 1977 indicate that 60 percent of the lodgepole pine type on the Medicine Bow National Forest is infested with *A. americanum* (Johnson et al, 1978). A conservative estimate of merchantable volume loss for the Forest is more than 4 million cubic feet per year.

Since 1981, over 91,000 acres have been surveyed and 12,000 acres treated with Forest Pest Management (FPM) funds (Table 2)(Johnson, 1986b). This summary only includes projects in which FPM funds were directly involved. Many more acres of control were accomplished through timber harvests and other stand entries, however, we have no record of the acres treated. The Forest Health Management (FHM) program consists of presuppression surveys, overstory removal, thinning and sanitation, and stand replacement. Since 1981, the program has received greater support and emphasis. Five year planning documents have been prepared and activities and funding requests have been integrated into the Forest planning and budgeting process. This strategy has insured a more continuous source of funding and program support than in the past, also resource managers can more effectively schedule time, resources and manpower.

The emphasis of the program in the Region has been on locating and defining those management units where infected non-merchantable overstory trees were left standing in older timber sale areas and pose a threat to established regeneration. In many cases, these young stands will not reach merchantable size if the infected residual trees are not felled or removed.

Comandra Blister Rust

Comandra blister rust causes stem and branch cankers on several species of pines, including ponderosa pine and lodgepole pine (Johnson, 1979; Johnson, 1986a). It occurs throughout North America, and is a serious cause of loss in many lodgepole pine stands in the central Rocky Mountains. For example, more than half of lodgepole pine basal area is in infected trees on the Wind River Ranger District, Shoshone National Forest (Geils and Jacobi, 1984). A 1977 disease survey on the Medicine Bow National Forest found that more than 26 percent of plots had rust infected trees and more than 17 percent of the trees on the plots were infected.

Comandra blister rust has a complex life cycle similar to that of the white pine blister rust organism, *Cronartium ribicola*. It has five different spore stages produced alternately on two hosts--a hard pine and the perennial herb for which the fungus is named, pale comandra (*Comandra umbellata)*. The spores that infect the pine are produced only on the comandra plants. These plants occur in sagebrush communities at various distances from the pine stands. The delicate rust spores are wind-dispersed for several miles from the comandra plants to pines during rainy days in summer. Infection occurs through needles and young shoots. The fungus spreads into the inner bark. One to three years later, the first evidence of the disease on pine appears: small drops of thick, sticky, reddish-orange liquid on the diseased bark. These drops contain spores.

The following spring and summer, pustules form on these same cankered areas. These pustules soon rupture and release another spore stage, which infects the alternate host, comandra plants. Infection of comandra results in yellow, blister-like spots on the leaves that, in turn, produce spores that infect other comandra plants.

In late summer or early fall, brown, hair-like structures develop on the underside of infected leaves. During mild, wet weather, these structures produce another spore that infects pines, thus completing the life cycle.

The rust attacks pines of all sizes and ages. Seedlings are the most susceptible and are usually killed within a few years by stem cankers. Infection of pole and sawtimber-size trees results in growth loss and mortality that prevents those trees from becoming merchantable.

As a rule of thumb, the number of years it takes the fungus to girdle the main stem equals twice its diameter, in inches, at the spot where the canker occurs.

Trunk infections in mature and overmature trees are accompanied by diagnostic crown symptoms. The first crown symptoms are dead branches in a narrow zone around the branch where the fungus entered the main stem. Above this zone, the crown thins and eventually dies, forming characteristic spike tops. These tops are resistant to decay and remain intact for many years.

A detailed study on the Laramie Ranger District, Medicine Bow National Forest, showed that rust incidence was highest in stands older than 40 years along forest edges adjacent to comandra habitat, but pine stands as far as 8 miles from comandra plants can be seriously infected. Spore dispersal from comandra plants to pines seems to be associated with easterly winds during long rainy periods. Disease incidence also increases with average tree height or diameter (Jacobi et al., 1993).

A summary of the forest conditions with the greatest potential to incur significant losses to the major insect and disease organisms is presented in Table 3.

C. Management Activities to Reduce Losses to the Major Insects and Diseases

Mountain Pine Beetle

Treatment of infested stands

There is a considerable body of literature that deals with the control of this insect (Amman et al., 1977; McGregor and Cole, 1985; Smith, 1990). Control of bark beetles can be divided into two basic types: direct and indirect. Direct control attempts to reduce the beetle population by killing large numbers of the insects. Some techniques include removal, processing, peeling or burning of infested trees or application of chemicals to kill the beetles as they emerge from infested trees. Although there have been extensive direct control programs in the past, their efficacy in the long term is now questioned. Direct control measures still have a place in protection of high value trees near homes and recreation sites and in the containment or elimination of very small, isolated outbreaks as they are beginning. Some of the newer direct control techniques that may have future utility under limited circumstances include the use of behavior-modifying, MPB-produced chemicals (pheromones) to disrupt beetle activities either by attracting or repelling them to or from specific areas.

The problem is that direct control operations attempt to treat the "symptoms" of an outbreak, i.e. large numbers of dying trees. Even if the outbreak could actually be suppressed, (which is doubtful and would be logistically substantial), the conditions which originally spawned the outbreak would still exist. It is usually just a matter of time before the beetle population begins to increase once again due to favorable conditions.

Indirect methods are usually the most economical and efficient in the long run. Indirect methods focus on the use of silviculture to create a mosaic of various stocking levels, age classes and tree species mixes. Such a mixture of stand conditions is not only more resistant to mountain pine beetle, but it also spreads the risk of outbreak among the various stand types.

Indirect methods of control attempt to create stand conditions that are unfavorable to the beetle. A number of silvicultural options exist which attempt to reduce basal area, average stand diameter and stand density. Patch cuts may be utilized to regenerate dense, mature stands and partial cuttings or thinning may be used to reduce stand basal area and densities within the stand. Evenaged and unevenaged management systems may be utilized to reduce stand susceptibility (Amman et al., 1989).

Lodgepole Pine Dwarf Mistletoe

Treatment of infested stands

The dwarf mistletoes are most easily and economically treated by silvicultural practices. Several features of these parasites make them ideal candidates for cultural management:

- Dwarf mistletoes require a living host to survive. Once an infected tree or branch is cut, the

mistletoe plant dies. There is no need to destroy the infected slash.

- Mistletoes are generally host-specific; that is they are usually confined to a single host species or group of closely related species. Immune or lightly infested species can be favored during stand treatments.

- Dwarf mistletoes spread slowly. Seed dispersal from a tall, isolated tree is usually limited to less than 60 feet. In even-aged stands, spread is even more limited, averaging 1 to 2 feet per year.

- Dwarf mistletoes have a long life cycle; mature plants take 4 to 6 years to develop from seeds. This long life cycle means the amount of disease builds slowly. If a stand is properly treated, mistletoe should not be a serious management problem in subsequent rotations.

- Infected trees and stands are easy to detect because of the presence of dwarf mistletoe plants, branch and stem swellings, and witches' brooms. Heavily infested stands show decline and mortality.

Presuppression surveys are utilized to define areas in need of treatment. Once the resource manager has located general problem areas, the biological need and effectiveness of proposed suppression projects can be evaluated.

Successful silvicultural techniques have been developed specifically for dwarf mistletoe control. These practices can be easily integrated into planned harvesting and intermediate stand treatments. These strategies are aimed at either the prevention or suppression of the disease dependent upon the age of the stand and management objectives. Because it is more effective to prevent mistletoes from becoming established than to eradicate them from infested stands or to replace severely infested stands, the priorities in control programs should be placed on prevention. Prevention can be accomplished by:

- Designing treatment units to take advantage of natural or artificial barriers (such as roads, streams, non-susceptible forests, openings, or meadows) that prevent reinvasion from adjacent infested stands.

- Felling or killing all infected trees before an area is planted or naturally regenerated.

- Using regeneration harvests when logging infested stands. Long, narrow harvest strips should be avoided.

- Regenerating stands with the shelterwood method leaving mistletoe-free or lightly infected residual trees. If infected trees must be retained (for instance in areas sensitive to visual quality objectives or for the protection of the site from adverse microsite conditions), they should be killed as soon as the site has regenerated and before the regeneration is 3 feet tall or 10 years old.

- Favoring non-susceptible tree species when regenerating a stand or making intermediate stand entries.

These strategies all reduce the likelihood of dwarf mistletoe spreading into a healthy stand. When a stand is already infested, all infected overstory and selected understory trees can be felled. This technique, known as sanitation-thinning, can be applied in lightly infested stands. Crop trees should be disease-free. However, lightly infected trees may be retained to meet the minimum-stocking guides. Replacing severely infested stands with healthy stands by cutting all infected trees, rollerchopping, or prescribed burning and regenerating may be recommended in some instances.

In developed sites and recreation areas, the emphasis of control programs has been to reduce spread from individual trees and prolong the life of trees by pruning infected branches. Resistant tree species may be planted in the understory with the eventual removal of the infected overstory trees.

Dwarf mistletoe suppression yields multiple benefits including:

- Dwarf mistletoe infection delays the economic maturity of stands, adversely affecting wood quality and tree seed production. Dwarf mistletoe suppression is necessary to insure increased productivity of stands in the future to meet the increased demand for wood products.

- Dwarf mistletoe suppression is necessary to protect other forestry investments, such as site preparation, tree planting, thinning and timber stand improvement. In addition, dwarf mistletoe control in infested stands prevents spread of the disease to adjacent healthy stands.

- Dwarf mistletoe suppression results in increased productivity per acre and under intensive management results in reduced acreage needed to meet timber targets. In this manner, we can concentrate harvesting activities on fewer acres at reduced cost. With the trend of withdrawal of forest land from timber production and harvesting, it is imperative that we increase the productivity of the remaining commercial forest stands.

- Dwarf mistletoe suppression reduces the susceptibility of stands to insect attack, particularly bark beetles, windthrow and natural fires.

- The silvicultural practices developed for dwarf mistletoe suppression have been proven to be very effective and provide control of the disease for the current and subsequent rotations.

What measures or combinations of treatments that should be used is dependent upon individual stand conditions, including stand age and composition, stand density, number of years to harvest, mistletoe incidence and distribution, and length of time the stand has been infested. Valuable tools -- tree and stand growth models and dwarf mistletoe infection models -- are available to aid the resource manager in simulating yields of infected trees and stands. Yields for a stand can be predicted under various management regimes and compared to no treatment. By comparing outputs and economic analyses of control costs, the manager can choose the best treatment for each infested stand and priority for treatment.

Comandra Blister Rust

Treatment of infested stands

Reduction of losses to this disease consists primarily of identifying heavily infested stands and harvesting as soon as management permits (Brown, 1977; Johnson, 1986a). If feasible, regenerate with tree species other than susceptible hard pines. Where seed trees are used to regenerate a stand, disease-free trees should be left as seed sources. Harvest merchantable trees with cankers on the lower or mid-portion of the stem before the fungus girdles and kills the tree. Cankers occurring between the base of the tree and a height of about 25 feet are usually lethal (Johnson, 1979).

Other than retaining more trees than stocking guides recommend, no practical control measures are available to suppress the rust in young stands. Increased stocking will, over time, be offset by rust-caused mortality. In marginally stocked stands, the disease may cause significant losses.

The strong association of site, stand, and alternate host factors with incidence of the disease provides managers with a means of determining rust hazard in stands of lodgepole pine. In stands where the hazard is so great that a commercial crop is marginal, an investment in intensive forest management practices should probally be reconsidered.

D. Survey Design and Methods

The standard Region 2 intensive stage II Stand Exam was used as the data base for this analysis, which consisted of 1 plot per 10 acres (10 chains by 10 chains spacing) and a minimum of 3 plots per stand. Contracts were awarded to complete the surveys.

The surveys were conducted on USDA Forest Service-administered forested sites where management activity might best be considered. Stands on slopes greater than 40% were excluded. For all of the exams, the stand boundaries were drawn on aerial photographs (approximate scale 1:24,000). The points to be surveyed were pinpricked using a grid to equally space them throughout the stand. The points were pinpricked prior to being taken to the field, but not numbered until the crew reached the points.

The crews used the US Geological Survey quad maps (1:24,000) and the aerial photographs to locate a known reference point (RP) to start their survey. Using a photo scale ruler, they determined the distance and azimuth from the RP to the first sample point, first point to second and so on. They used a compass to determine the direction (azimuth) of travel and used pacing to determine the distance.

After arriving at the first point, the crew determined the variable radius, Basal Area Factor (BAF) prism to be used for the stand. The same BAF (10,20,30 or 40) was used throughout the stand. Trees determined by prism to be "in the plot" were measured. The fixed plot size for the understory trees was always 1/300 acre.

Starting at North, all trees greater than or equal to 5.0 inches dbh were checked using a prism to determine if they fell within the plot. For each "in" tree, standard mensurational data were collected as well as dwarf mistletoe rating (DMR) and damage and cause of death for dead trees. After the

overstory trees were recorded, the understory trees (all trees less than 5.0 inches dbh) which fell in on the 1/300 acre fixed plot were recorded.

The completed data was entered into the Oracle based RMRIS data base (Rocky Mountain Resource Information System) on the USFS Data General computer and summaries of each stand were obtained through the RMSTAND portion of the program (Appendix A).

The inventory for the state and private lands was collected by a walk-through survey with plots taken in scattered locations. Forest type, age, growth rate, height, basal area, diameter, crown ratio, dwarf mistletoe incidence and understory plant species were recorded. Since this information was collected and summarized differently from NFS lands, it is not included in the detailed analysis, however, summaries are provided for comparison.

E. Survey Results

Vegetation Of The Cold Springs Analysis Area

Ownership and cover type patterns of the entire Analysis Area are as follows: 39% of the acres of the Analysis Area is National Forest land, while the remaining consists of Bureau of Land Management (1%), State of Wyoming (9%), and private lands (51%)(Figure 3). The NFS land is 90% forested, while the remaining area is non-forested (forblands, grasslands, streams, reservoirs, etc.). The inventoried NFS lands, as determined by the 1994-1996 stand examinations, contain 81% lodgepole pine cover type, 2% ponderosa pine cover type, 1% limber pine cover type, 12% spruce-fir cover type, 2% Douglas-fir cover type, and 2% aspen cover type (Table 4, Figure 4). The state and private lands are 78% lodgepole pine cover type, 11% aspen cover type, 5% ponderosa pine cover type, 4% spruce-fir cover type, and 2% Douglas-fir cover type. As stated previously, the focus of this evaluation is on the lodgepole pine cover type.

Insect and Disease Conditions As Determined By The Survey

Mountain Pine Beetle Conditions

Table 5 summarizes the mountain pine beetle risk levels identified by the survey. Fifty-one percent of the surveyed area (50% of the number of stands) was found to be at moderate to high risk.

A summary of the data for state and private lands showed 56% of the area at moderate to high risk.

Dwarf Mistletoe Conditions

Table 6 summarizes lodgepole pine dwarf mistletoe incidence and severity, as determined by the survey. Dwarf mistletoe infection (DMI) rating (none, low, moderate, high) was determined for each stand. DMI ratings are distinquished from the more commonly used DMR (Dwarf Mistletoe Ratings) values in that DMI values only include infected trees in the average rating for a stand. DMI ratings are thus a measure of how seriously infected the infected trees are in a given area. DMI calculations tend to inflate the range of values between stands (DMI is generally greater than DMR), and were thus of greater use in separating out low, moderate and high levels of infestation.

While dwarf mistletoe is widespread throughout the analysis area (76% of the total surveyed acres), only 19% of the stands were moderately to highly infected. The 76% figure for total acreage affected by dwarf mistletoe is higher than the 60% average for the entire Medicine Bow National Forest estimated by the 1977 survey conducted by Johnson and others (Johnson et al, 1978). Management activities to address dwarf mistletoe may be considered for the stands in the moderate to high DMR classes.

A summary of the data for state and private lands showed 87% were moderate and none were rated high.

Comandra Blister Rust Conditions

Table 7 summarizes the incidence of comandra blister rust as determined by the percentage of live trees per acre 5.0 inches and larger with a stem rust recorded during the inventory. Thirty-nine percent of the acres (36% of the number of stands) had some rust present, whereas only 6% were rated as moderate to high levels. This level of rust infection is higher than that recorded for the entire Forest.

No information is available for state and private lands.

Insect/Disease Interactions

Analyses of areas with various combinations of mountain pine beetle risk, dwarf mistletoe, and comandra blister rust are presented in Table 8. Assuming that the inventoried stands are representative of the area as a whole, 12% of the area is rated as moderate to high susceptibility to MPB x DM (area in the matrix that is enclosed by the box in the lower right corner), 5% of the area rated as moderate to high to MPB x CBR, and 3% of the area rated as moderate to high to DM x CBR.

For state and private lands, 49% of the area was moderate to high susceptibility to MPB x DM. Other combinations of risk were not made due to lack of data.

Mountain Pine Beetle x Dwarf Mistletoe

As shown in the Table 8-1, approximately 77% of the inventoried acres have both dwarf mistletoe (low, moderate or high levels) and mountain pine beetle (low, moderate or high susceptibility levels) risk present. However, 12% of the acreage is rated moderate to high for both mountain pine beetle and dwarf mistletoe incidence. In the latter areas, thinning alone may not adequately address both problems. Stands with DMI ratings of 2 or greater generally cannot be sanitized by thinning and must undergo sanitation, patch-cutting or clearcutting. Particular treatments must be determined on a stand-by stand, landscape-by-landscape basis. In any case, where thinning may be applied to address the dwarf mistletoe situation (where stand DMI < 2.0), sanitation thinning aimed at dwarf mistletoe and thinning aimed at reducing bark beetle risk may be combined into a single integrated treatment.

Mountain Pine Beetle x Comandra Blister Rust

As shown in Table 8-2, approximately 39% of the acres have both mountain pine beetle (moderate to high susceptibility levels) and comandra blister rust (low, moderate or high levels) management concerns. However, only 5% were rated moderate to high for both organisms. Management activity could be easily scheduled for these stands.

Dwarf Mistletoe x Comandra Blister Rust

As shown in Table 8-3, approximately 33% of the acres have both dwarf mistletoe (low, moderate or high levels) and comandra blister rust present. However, only 5% were rated moderate to high for both organisms. As for the previous case, management activity could be concentrated in these stands.

F. Forest Pest Model Runs and Interpretation

Sampling Stands For Pest Model Runs

In order to gain a better understanding of the potential impacts of mountain pine beetle and lodgepole pine dwarf mistletoe on the lodgepole pine stands of the Cold Springs Analysis Area, a sample of inventoried stands were chosen as examples to simulate the effects of these organisms over 100 years (10 cycles). The effects of comandra blister rust were not included in this portion of the analysis since a model is not currently available that is linked to the Forest Vegetation Simulator (FVS).

Stand growth was simulated utilizing FVS Version 6.2, Central Rockies Lodgepole Pine Variant. To simulate mountain pine beetle, the Mountain Pine Beetle pest extension model was used. To simulate dwarf mistletoe effects, the base FVS model was run with and without dwarf mistletoe effects (MISTOFF engaged and not engaged). Twelve stands from the survey were chosen as samples for model runs (6 stands for each model representing low, moderate and high risk). To insure that a wide variety of initial insect and disease intensities were represented, the stands were chosen from the various strata identified from the DM x MPB interaction grids (Table 8-1 and 8-2).

Mountain Pine Beetle

In order to demonstrate the impact of MPB within the Analysis Area in the future, inventoried stands were used in a number of runs of the FVS model. The design of this simulation model allows the user to manipulate stand conditions and thus gain some insight into the types of impact the various components of the ecosystem are having on the final condition of the stand. The results of these computer simulations are not meant to be "predictions" of future conditions, but instead will allow a user to consistently compare the impact of the various parameters.

The stand data was divided into 3 groups (low, moderate and high) according to its MPB risk rating. Two stands were chosen for each risk group for a total of 6 stands. Each of the chosen stands was run through the model with and without an outbreak in the first cycle (10 years). The dwarf mistletoe model was turned off so the MPB effect could be determined. Table 9-1 lists the stands selected to be run in the model as well as some key stand characteristics. Table 9-2 gives the results

of the runs under the assumption that there is no MPB outbreak versus an outbreak starting in the first cycle. The volume is expressed in terms of total cubic feet.

The FVS model simulates an outbreak of MPB by taking stand factors into account and keeping track of tree mortality during the cycle of the simulated outbreak. Figures 5-7 demonstrate the way that tree mortality may occur in a stand. Once the stand has been subjected to the outbreak, the decreased volume renders the stand less susceptible to additional outbreaks in the near term.

These results indicate a loss in volume that ranges from 10 to 46% over the 100-year length of the simulation. The expression of these losses does not simply represent just a loss of timber volume but also represent increased fuel loading, changes in value to wildlife, recreational amenities, etc. Volume losses as great as 46% represent the dramatic changes in stand structure and dynamics of which MPB is capable.

Just as these stands differed greatly, so did the results of the simulation runs. The generally slow recovery from an outbreak illustrates the long-term impact of a MPB outbreak.

Lodgepole Pine Dwarf Mistletoe

Six stands, representing a sample of the stands inventoried with varying degrees of dwarf mistletoe infection, were selected to simulate the effects of dwarf mistletoe over 100 years. The list of stands analyzed, with stand age, percent of lodgepole pine, and percent of lodgepole pine with dwarf mistletoe is presented in Table 10-1.

Each stand was run with the current dwarf mistletoe condition to determine growth and mortality effects of the disease and again without the dwarf mistletoe function. The difference between the two simulations gave the effect of the disease over the simulation period. A summary of the results of the stand simulations is presented in Table 10-2.

The impact of dwarf mistletoe on cubic volume over the 100-year period for three of the stands (high, medium and low DM levels) is shown in Figures 8-10. The reduction in total cubic foot volume of stands infested with dwarf mistletoe ranged from 23 to 78% over the simulation period. The volume reduction was greatest in stands with the higher dwarf mistletoe ratings. In reality, all of these stands are currently near or above the recommended harvest age of 100-120 years (range from 113-213 years), thus there is no silvicultural advantage in delaying harvest of these stands. Those stands with the greatest amount of disease should be given highest priority for management activities in order to reduce future losses to the disease and reduce the potential for MPB attack.

G. Desired Forest Condition

As mentioned in the Introduction, the Douglas Ranger District, including portions of the Analysis Area, has been the scene of past vegetation management activities. Prescribed silvicultural treatments included regeneration harvests of mature, susceptible lodgepole pine stands and non-commercial and commercial thinning of lodgepole pine stands.

Almost 1,800 acres of state and private lands have been treated by regeneration cuts, overstory removal and commercial thinning. An additional 2,700 acres are planned for treatment within the next 10 years through forest stewardship plans.

The Medicine Bow National Forest Plan determined a desired condition in terms of successional/structural stage distribution for forest types on the Forest. This distribution is considered optimum for the Forest to provide a sustained yield of wildlife habitats, visual quality, dispersed recreation experiences, wood products, and resistance to insects and disease. Table 11 compares desired conditions with existing conditions in the Analysis Area.

As can be readily seen (Figure 11), the current structural stages for lodgepole pine, ponderosa pine and spruce-fir are predominately in late and old growth classifications: lodgepole pine (86%), ponderosa pine (99%), spruce-fir (99%), and do not meet desired levels. To remedy this situation will take many years as stands grow into the next older structural stage and harvesting of late seral stages affords an opportunity to create younger seral stages. A balance is needed to be found between the harvest of late seral stages and a decision to allow them to grow into old growth classes.

Where mountain pine beetle and dwarf mistletoe are present or the stand has the characteristic of high risk to these agents, it might be best to concentrate harvest activities in these stands. Stands that have been identified to be at high risk to more than one agent should receive highest priority for management. If epidemics of mountain pine beetle develop, stands that are in late seral stages will incur the highest level of mortality. The various cultural treatments and their relative effectiveness in reducing losses to the major insects and diseases present in the Analysis Area are summarized in Table 12.

In order to demonstrate the effects of various cultural treatments and their effectiveness in reducing susceptibility to damage by mountain pine beetle and dwarf mistletoe, a sample of stands was chosen for FVS projections. To reduce the numbers of stands that might be considered for projections, several criteria were developed to select stands. Only stands classified as lodgepole pine were considered. Also stands that were larger and thus included more sample points were selected. Stands where several different silvicultural prescriptions might be effective were also included.

Two stands for each treatment were run with and without cultural treatments. Two cycles (20 years) was chosen as the projection time since the forest planning cycle is 10 to 20 years long and regeneration would be established within this period. A description of the cultural treatments and listing of the stands is presented in Appendix B - Tables 1 and 2. FVS stand summaries before and 20 years after application of various cultural treatments are presented in Appendix B - Table 3. In addition, examples of Stand Visualization Simulations (SVS) are presented for each cultural treatment (Appendix B - Figures 1-8).

H. Recommendations

Fire suppression, coupled with a lack of large-scale harvest activities in the Analysis Area has altered stand structure by increasing stand stocking and density levels. At present, late successional stages predominate, to the exclusion of the early, intermediate, and old-growth stages. Fire treatments, selected harvests and thinnings may be utilized to bring about the desired forest condition as defined in the Medicine Bow National Forest Plan.

Fire cannot immediately be returned to all sites as they currently exist and still meet other management objectives. Ladder and surface fuels have increased beyond historic levels and may hamper the direct application of prescribed fire. Pretreatment to remove some trees and downed woody fuels may be required to reduce fuels to a manageable level before prescribed burning can occur. Once fuels are reduced, fire can be applied on a larger scale but perhaps not at the historic landscape scale. However, when planning and performing these treatments, the potential impacts of insects and disease must be taken into account. Of particular concern are the impacts of mountain pine beetle and lodgepole pine dwarf mistletoe in the lodgepole pine cover type. Action, as well as the lack of action, will have specific effects on the intensity, impacts and distribution of these insects and diseases. In many cases, it will be necessary to adjust planned silvicultural practices to take into account specific pest situations. As stated at the outset, this analysis has concentrated on the lodgepole pine cover type. Recommendations to address specific insect and disease situations that are of concern in the Analysis Area are as follows:

- The lodgepole pine cover type of the Analysis Area is at risk for a substantial mountain pine beetle outbreak. By our estimation, approximately 50% of the acres in the Analysis Area (51% of surveyed stands) are at moderate or high risk, and 1% (1% of surveyed stands) are at high risk. Controlling tree density can reduce the beetle risk. However, stocking control would have to be implemented on a large number of acres to affect the Analysis Area's stands susceptibility to a beetle outbreak. In general, high risk stands and groups of stands (denser, larger diameter stands in particular) should be targeted for treatment first. In areas below 9,200 feet in elevation, stocking should be reduced to an evenly spaced basal area of 120 square feet or less (McGregor et al. 1987) and an average stand diameter of 8 inches dbh or less (Amman et al. 1988) and held throughout the rotation.

- Although lodgepole pine dwarf mistletoe is widespread in the Analysis Area, moderate to high levels were recorded for only 19% of the stands. However, mistletoe levels in many stands and landscapes are such that control measures may be needed. Three percent of the stands were rated with high DMI levels and 16% had moderate DMIs. Cultural techniques, such as clearcutting, patch-cutting, seed tree or shelterwood cutting, and sanitation thinning, can be effectively utilized to reduce the impact of dwarf mistletoe. In most cases, unevenaged management and dwarf mistletoe management is a poor mix. If seed tree or shelterwood cutting is employed, lightly infected shelterwood or seed trees may be retained, but they must be removed before the developing regeneration reaches 3 feet in height or 10 years in age. Controlled burns may also used to sanitize stands, but any residual infected trees left after the burn must be removed in a timely manner. The particular treatment to be used must be determined on a case-by-case basis, according to the individual stand conditions and the distribution and intensity of the dwarf mistletoe infestation. In general, sanitation thinning is not recommended in stands with a dwarf mistletoe rating (DMR) of 2 or greater.

- Approximately 77% of the acres have both dwarf mistletoe (low to high levels) and mountain pine beetle (low to high risk levels) management concerns. However, because dwarf mistletoe reduces stand vigor, bark beetle risk may be elevated in these stands. Treatment of moderate-high MPB risk stands with dwarf mistletoe is thus a higher priority than treatment of moderate-high MPB risk stands without mistletoe. In stands where DMR ratings are less than 2.0, general thinning to lower bark beetle risk and sanitation thinning to address the dwarf mistletoe situation may be combined into a single integrated treatment. In stands where the DMR rating is greater than 2.0, clearcutting, patch-cutting, seed tree or shelterwood cutting may be necessary to mitigate the effects of dwarf mistletoe.

- o Stand conditions conducive to MPB outbreak exist on 173 acres in 9 stands of ponderosa pine in the inventoried area (see BRSK in Appendix A for ponderosa pine stands). Risk-ratings for these stands predict moderate to high levels of mortality should an MPB outbreak occur. In light of the recent MPB outbreak in ponderosa pine on Laramie Peak, similar susceptible ponderosa pine stands in the Cold Springs Analysis area are cause for concern. Mitigation measures for MPB in ponderosa pine are similar to those for MPB in lodgepole pine.

I. Conclusions

Future forest plans should be based on similar landscape level analyses to determine where to concentrate management activities and to assure full consideration of the important functions of insects and diseases. Only those insects and diseases, which we judged likely to have significant effects on succession and disturbance processes, have been analyzed.

Existing hazard rating systems for mountain pine beetle and dwarf mistletoe provide excellent planning tools that, in combination with stand exam data, can be applied over landscapes to determine where management activities should be directed. Prioritization of stands to be treated is an important component of an efficient risk reduction strategy.

The current and projected future conditions on the Forest ensure that insects and diseases will continue to play significant roles in the development, successional processes and both the small and large scale level disturbance processes at work on the Forest. Most major forest vegetation types have greater than 60% of their structural stages in mature/overmature classes that are conducive to outbreaks of the most important insect and disease agents (Table 1). The sampled stands within the Cold Springs Analysis area indicate that the percent of stands in the mature/overmature classes are even greater at 86-100% (Table 4).

This situation has largely developed as a result of fire suppression that has been practiced on the Forest for most of this century, interrupting the natural disturbance regime which helps maintain ecosystem structure and health. Growth loss and mortality will continue to occur, particularly where access, topography or other resource restraints preclude silvicultural treatment of stands.

We can influence the outcome of insect and disease outbreaks at the stand level on a project basis. Specific recommendations on how to accomplish this have been presented. Risk-rating systems exist for most of the important insect and disease organisms and both forest stand and pest models can be helpful in projecting future scenarios and determining management options.

Many of the stands analyzed in this document are currently at high risk to some large-scale outbreaks, especially by mountain pine beetle. Currently there is a large backlog of stands that should be treated in order to bring the entire area within the guidelines set by the desired stand conditions. Because mountain pine beetle outbreaks are cyclical in nature, if these conditions are allowed to persist, it will not be a question of if an outbreak will occur, but when it will occur.

An aerial sketchmapping mission conducted over the Analysis Area in August 1996 revealed only scattered single or small groups of mountain pine beetle infested trees. For the most part, mountain pine beetle populations are currently in an endemic phase throughout the Forest. However, we need to be vigilant and will continue to monitor the Forest as needed.

Lodgepole pine dwarf mistletoe is more widespread in the Analysis Area than in the Forest as a whole, however, only 19% of the stands were moderately to highly infested. Many stands should probably be scheduled for treatment. Patch-cutting, clearcutting, shelterwood or seed tree cutting remain the only viable treatment alternatives where stand dwarf mistletoe ratings are moderate or high.

With our limited ability to treat large landscapes and other administrative considerations affecting forest management activities, we will have to accept the changes that will occur across most areas of the Forest. Small-scale disturbance events may result in greater biodiversity and may help in achieving long term forest management goals, whereas, large catastrophic-scale events may be unacceptable. While management efforts must be directed toward the avoidance of these catastrophic events, opportunities to improve the health of the forest should be taken wherever possible.

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Tables 1-12.

Table 1. Major forest types on the Medicine Bow National Forest and condition.

Forest type	Acres 1/	Acres mature/overmature	Percent
Lodgepole pine 2/	496,758	417,275	84
Spruce/fir 3/	184,527	118,100	64
Ponderosa pine 3/	87,442	57,710	66
Aspen 2/	81,219	47,920	59
Douglas-fir 3/	8,204	5,170	63
Totals	858,150	646,175	75

1/ Source of data: USDA Forest Service 1987. Inventory of National Forest System lands administered by Region 2. Book 3 Forest and regional area x age class curves. Timber, Forest Pest and Cooperative Forestry Mgmt., Rocky Mountain Region.

2/ Classified as mature/overmature if 80 years or older.

3/ Classified as mature/overmature if 120 years or older.

Table 2. Summary of dwarf mistletoe program expenditures and accomplishments for the Medicine Bow National Forest (1981-1995) funded by Forest Pest Management.

Fiscal Year	FPM $	Acres surveyed	Acres treated
1981	1,600	--	60
1982	33,200	12,000	--
1983	41,400 (155,000) 1/	--	726 (782) 1/
1984	95,300	600	2,800
1985	83,900 (65,600) 2/	5,100	3,102 (1,450)2/
1986	26,500	--	500
1987	71,200	2,291	1,856
1988	123,800	17,507	1,717
1989	--	--	--
1990	--	--	--
1991	32,700	--	525
1992	--	--	--
1993	57,700	10	305
1994	60,200	11,725	--
1995	67,600	42,000	576
Totals	695,100 (202,600) 1,2/	91,233	12,167 (2,232) 1,2/

1/ Figures in parentheses funded by the Jobs Bill.
2/ Figures in parentheses funded with Timber Stand Improvement funds.

Table 3. Forest conditions with the greatest potential to incur significant losses to the major insect and disease organisms.

Organism	Stands with greatest potential to incur significant losses
Mountain pine beetle	Overstocked, clumpy ponderosa pine stands averaging 8 inches or more in diameter with basal areas of 120 square feet or greater per acre measured around any individual tree; stands of low vigor lodgepole pine that are overstocked and overmature (80 years or older) averaging 8 inches dbh or more.
Dwarf mistletoes	Multistoried host stands with infected overstories. Pure stands that are already infected. Young stands adjacent to infected stands of the same species.
Comandra blister rust	Pine stands adjacent to sagebrush habitats containing the alternate host plant, *Comandra.spp.* Marginally stocked stands with a high incidence of disease.

Table 4. Major forest types within the Cold Springs Analysis Area, Douglas Ranger District, Medicine Bow National Forest (NFS inventoried lands only).

Forest type	Acres 1/	Acres mature/overmature	Percent
Lodgepole pine 2/	8,809	7,598	86.3
Ponderosa pine 3/	173	173	100.0
Limber pine 3/	98	NA	NA
Spruce/fir 3/	1,308	1,296	99.1
Douglas-fir 3/	181	NA	NA
Aspen 2/	164	NA	NA
Totals	10,733	--	--

1/ Source of data: USDA Forest Service Stand Exam Surveys, Douglas Ranger District.

2/ Classified as mature/overmature if 80 years or older; includes habitat structural stages 4A, B, C and 5.

3/ Classified as mature/overmature if 120 years or older; includes habitat structural stages 4A, B, C and 5.

NA = Not Available

Table 5. Mountain pine beetle risk analysis for the lodgepole pine cover type of the Cold Springs Analysis Area.

Inventoried Analysis Area (8,809 acres, 372 stands)			
MPB Risk Rating:	Low:	4,373 acres (49%),	183 stands (49%)
	Moderate:	4,387 acres (50%),	184 stands (49%)
	High:	49 acres (1%),	5 stands (1%)
	TOTAL	**8,809 acres**	**372 stands**

Table 6. Dwarf mistletoe conditions for the lodgepole pine cover type of the Cold Springs Analysis Area.

Inventoried Analysis Area (8,809 acres, 372 stands)			
DMI:	None (DMI = 0):	2,045 acres (23%),	118 stands (32%)
	Low (DMI = 0.1-1.99):	5,078 acres (58%),	182 stands (49%)
	Moderate (DMI = 2.0-3.99):	1,439 acres (16%),	61 stands (16%)
	High (DMI = 4.0-6.0):	215 acres (2%),	10 stands (3%)
	not rated:	32 acres (0.4%),	1 stand (0.03%)
	TOTAL	**8,809 acres**	**372 stands**

Table 7. Comandra blister rust rating for the lodgepole pine cover type of the Cold Springs Analysis Area.

Inventoried Analysis Area (8,809 acres, 372 stands)			
CBR:	None (CBR = 0):	5,357 acres (61%),	237 stands (64%)
	Low (CBR = 1-10):	2,881 acres (33%),	112 stands (30%)
	Moderate (CBR = 11-20):	455 acres (5%),	17 stands (5%)
	High (CBR = > 20):	116 acres (1%),	6 stands (1%)
	TOTAL	**8,809 acres**	**372 stands**

Table 8. Interactions between mountain pine beetle risk, dwarf mistletoe, and comandra blister rust incidence at the Cold Springs Analysis Area (acres/%).

1. Dwarf Mistletoe Infection x Mountain Pine Beetle Susceptibility

Dwarf Mistletoe Infection	Susceptibility to Mountain Pine Beetle: Low	Moderate	High
None (DMI = 0)	1273 (14.5)	723 (8.2)	49 (0.6)
Low (DMI = 0.1-1.99)	2592 (25.5)	2549 (32.4)	0
Moderate (DMI = 2.0-3.99)	416 (4.7)	1023 (11.7)	0
High (DMI = 4.0-6.0)	155 (1.8)	60 (0.7)	0

2. Comandra Blister Rust x Mountain Pine Beetle Susceptibility

Comandra Blister Rust Rating	Susceptibility to Mountain Pine Beetle: Low	Moderate	High
None (0% infected)	2883 (32.7)	2433 (27.6)	49 (0.6)
Low (1-10% infected)	1380 (15.7)	1489 (16.9)	0
Moderate (11-20% infected)	99 (1.1)	360 (4.1)	0
High (> 20% infected)	11 (0.1)	105 (1.2)	0

3. Dwarf Mistletoe Infection x Comandra Blister Rust Rating

Dwarf Mistletoe Infection	Comandra Blister Rust Rating: None 0%	Low 1-10%	Moderate 11-20%	High > 20%
None (DMI = 0)	1515 (17.3)	367 (4.2)	136 (1.5)	27 (0.3)
Low (DMI = 0.1-1.99)	3063 (34.9)	1820 (20.7)	184 (2.1)	11 (0.1)
Moderate (DMI = 2.0-3.99)	661 (7.5)	605 (6.9)	133 (1.5)	40 (0.5)
High (DMI = 4.0-6.0)	86 (1.0)	85 (1.0)	6 (0.1)	38 (0.4)

Table 9. Results of Forest Vegetation Simulator/Mountain Pine Beetle Model runs.

1. Stands Run Through FVS-MPB Model Simulations

Stand ID	Stand age	Elevation (ft)	BA	MPB risk-rating
110170-0027	236	8200	224	1
110161-0009	228	8500	133	1
110141-0030	150	8800	100	3
110165-0025	118	8600	186	3
110174-0060	116	8100	170	5
110136-0008	99	7700	100	5

2. Volume Loss After 10 Cycles (100 yrs.) - MPB Outbreak Starting In First Cycle

Stand ID	Cubic volume without outbreak	Cubic volume with outbreak	Vol. diff. (cu. ft.)	Reduction in volume (%)
110170-0027	7039	5055	1984	28.2
110161-0009	4907	4301	606	12.3
110141-0030	5079	4220	859	16.9
110165-0025	7619	5658	1961	25.7
110174-0060	8243	4412	3831	46.5
110136-0008	2864	2566	298	10.4

Table 10. Results of Forest Vegetation Simulator/Dwarf Mistletoe Model runs.

1. Stands Run Through FVS-DM Model Simulations

Stand identification	Stand age	LPP (%)	DMI	LPP with DM (%)
110142-0023	213	54.7	1.3	7.7
110177-0016	124	66.7	1.4	20.8
110143-0072	113	64.9	2.7	98.6
110177-0035	155	73.2	2.9	89.5
110143-0080	162	86.9	4.0	65.3
110177-0036	179	75.0	4.6	59.0

2. Volume Loss Due To Dwarf Mistletoe After 10 Cycles (100 yrs.)

Stand identification	Cubic foot volume wo/DM	volume w/DM	Vol. diff. (cu. ft.)	Reduction in volume (%)
110142-0023	4143	2995	1148	27.7
110177-0016	6239	4820	1419	22.7
110143-0072	7586	3593	3993	52.6
110177-0035	5991	2338	3653	60.9
110143-0080	4787	1040	3747	78.3
110177-0036	5418	1904	3514	64.8

Table 11. Comparison of the desired forest condition with forest conditions at the Cold Springs Analysis Area 1/.

	SUCCESSIONAL/STRUCTURAL STAGE 2/											
	EARLY 3/			INTERMEDIATE 3/			MATURE 3/			OVERMATURE 3/		
FOREST TYPE	Age (yrs)	Current (%)	Desired (%)	Age (yrs)	Current (%)	Desired (%)	Age (yrs)	Current (%)	Desired (%)	Age (yrs)	Current (%)	Desired (%)
Lodgepole Pine	0-40	<1	12	41-80	13	12	81-140	57	56	140+	29	20
Spruce/Fir	0-50	<1	14	51-80	0	16	81-140	27	50	140+	72	20
Ponderosa Pine	0-40	0	10	41-80	0	20	81-140	70	50	140+	29	20

1/ The assumptions used in developing the "Desired" situation were developed based on the Medicine Bow NF Plan.
2/ Successional/Structural Stage = Breakdown by age class (inventory for forest types).
3/ Timber Vegetation Classification:

EARLY	Grass/Forb & Seedling/ Sapling (trees 0" - 4.9" DBH)
INTERMEDIATE	Pole Stand (trees 5" - 8.9" DBH)
MATURE	Sawtimber (trees 9"+ DBH)
OVERMATURE	Stands older than 140 years with large trees and old growth characteristics

Table 12. Comparison of the relative effectiveness of cultural treatments in addressing forest insects and diseases of concern.

Organism	Cultural Treatment					
	CC	THIN (A)	THIN (B)	SHEL	ST	PF
MPB	+++	++	+	+	++	+++
DM	+++	++	+	+	+++1/	+++
CBR	+++	++	?	?	?	+++
MPB + DM	+++	++	+	+	++	+++
MPB + CBR	+++	++	?	?	?	+++
DM + CBR	+++	++	?	?	?	+++

Organism: MPB = Mountain pine beetle, DM = Dwarf mistletoe, CBR = Comandra blister rust.

Cultural treatments: CC = clearcut, THIN (A) = thin from above, THIN (B) = thin from below, SHEL = shelterwood, ST = seed tree, PF = prescribed fire.

+++ = most effective, ++ = moderately effective, + = least effective, ? = unknown.

1/ Remove seed trees within 10-15 years to prevent infection of regeneration.

Figures 1-11.

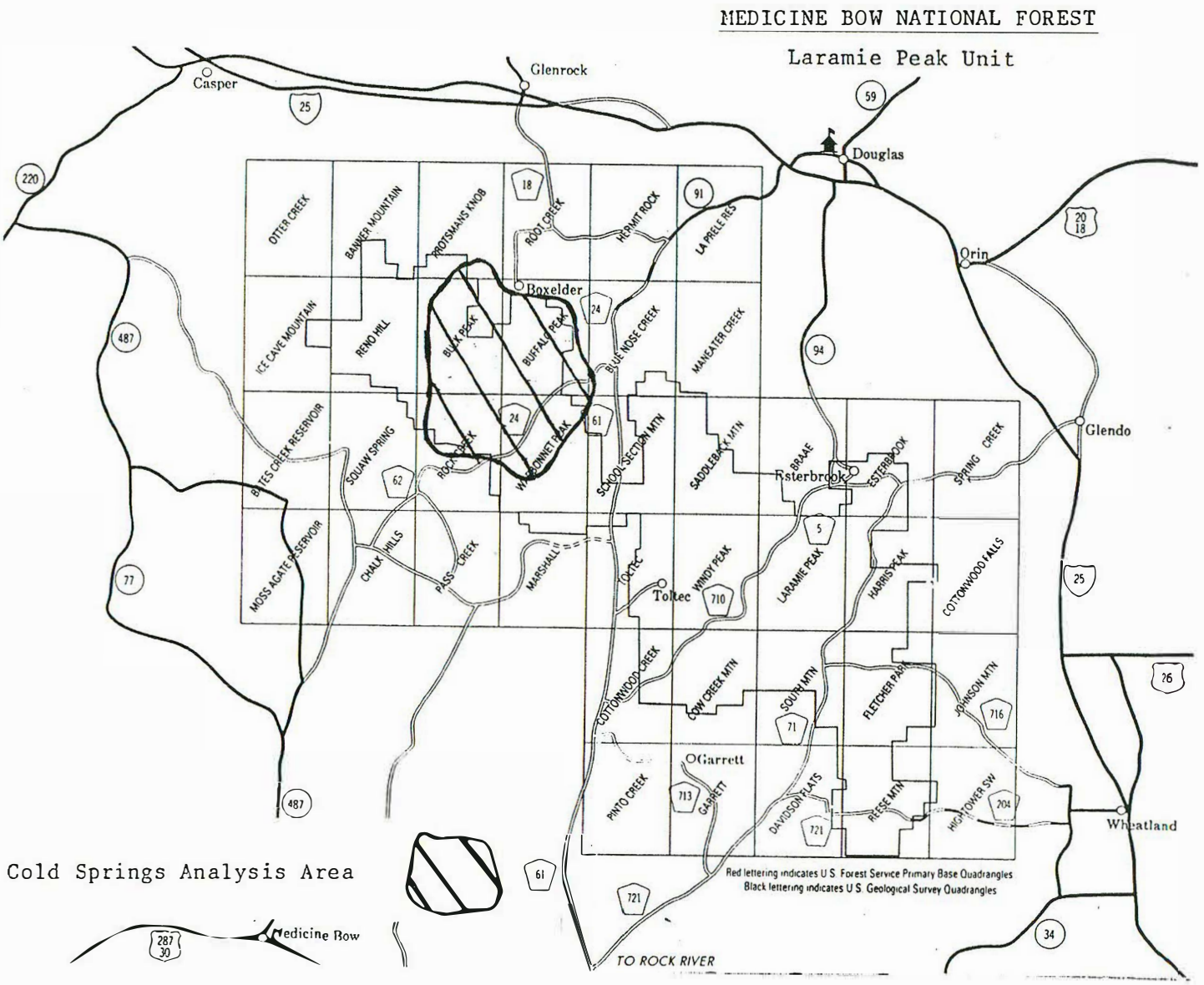


Figure 1. General location of the Cold Springs Analysis Area

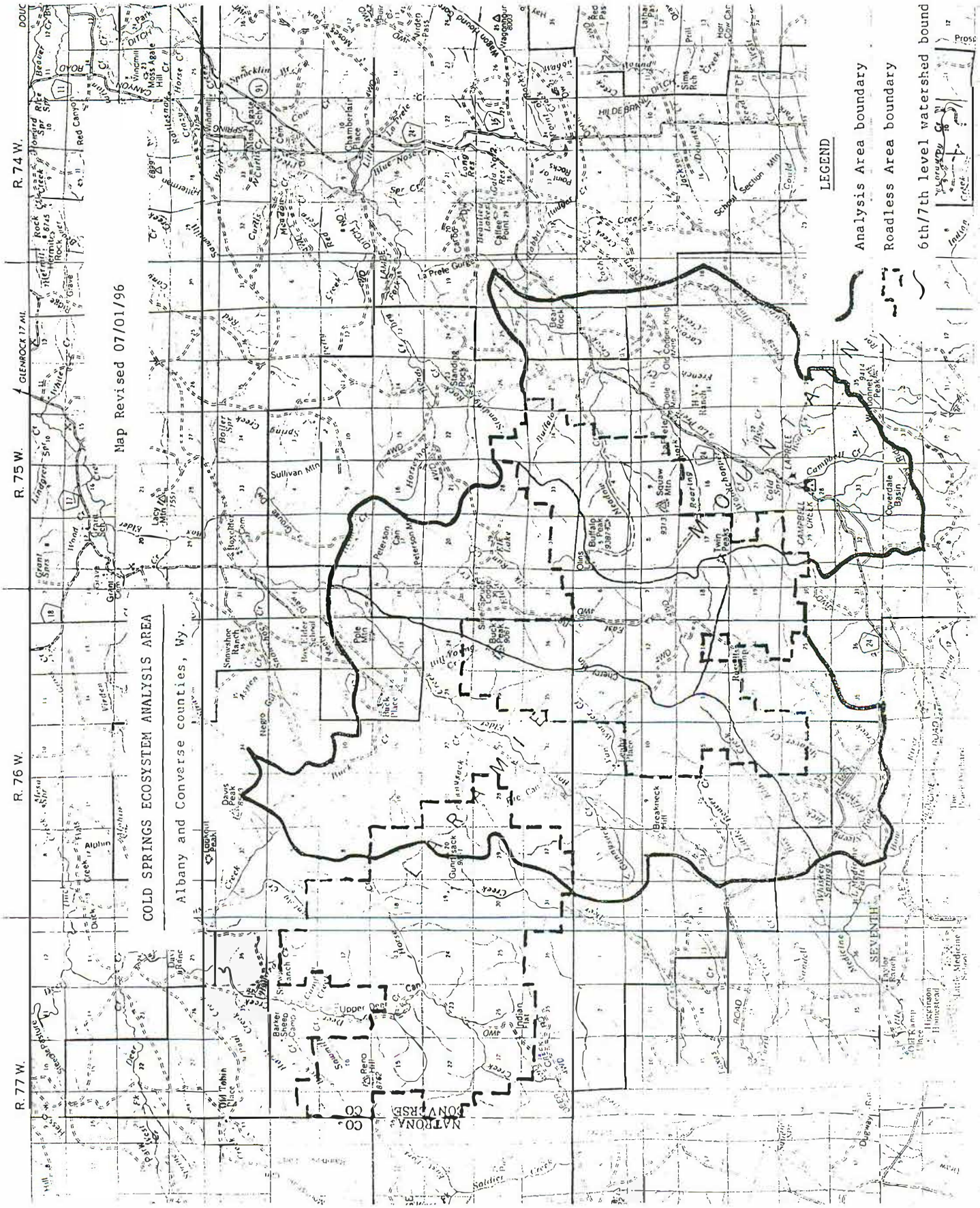
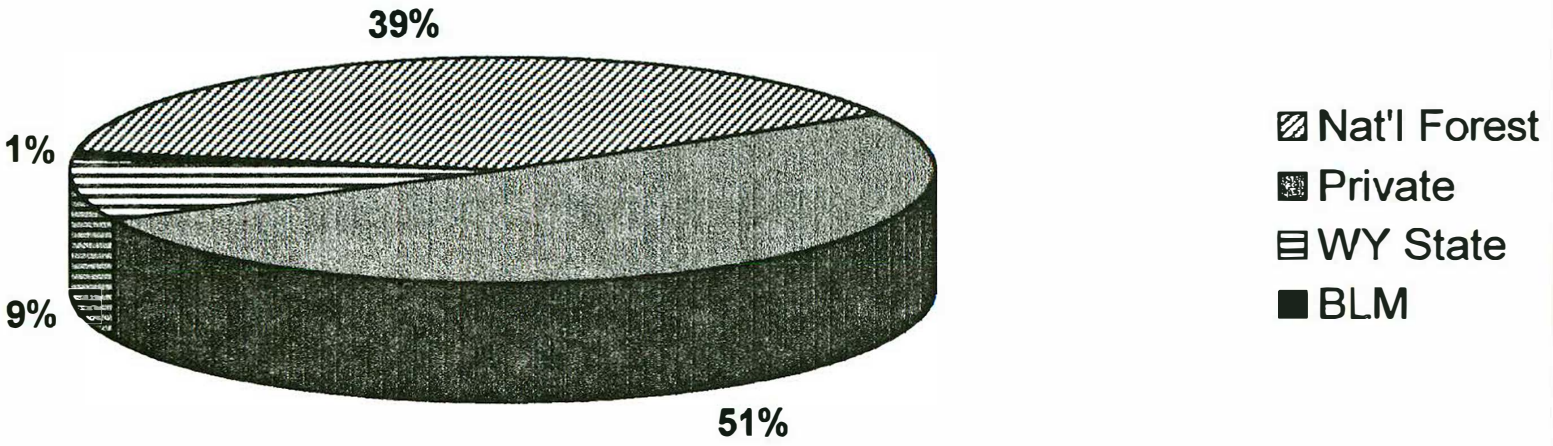


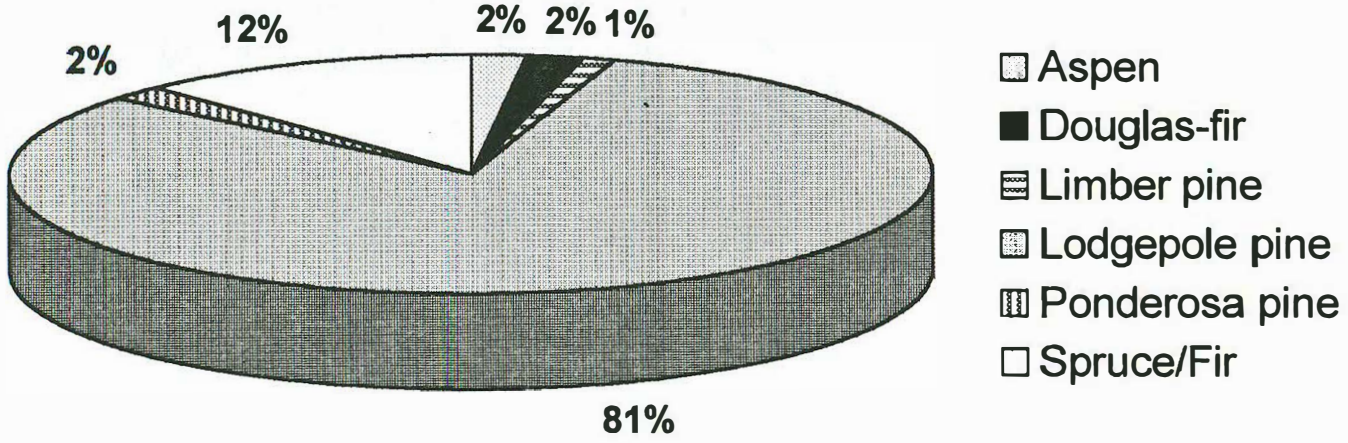
Figure 2. Detailed map of the Cold Springs Analysis Area

Figure 3
Land Ownership within the Cold Springs Analysis Area



Analysis Area = 63,180 acres

Figure 4
Cover Types of Inventoried, USFS-administered Lands
within the Cold Springs Project Area



Inventoried Area = 10,741 acres

Figure 5
Forest Vegetation Simulator Projection:
impact of mountain pine beetle on cubic volume
[Site 110161-0009, low risk]

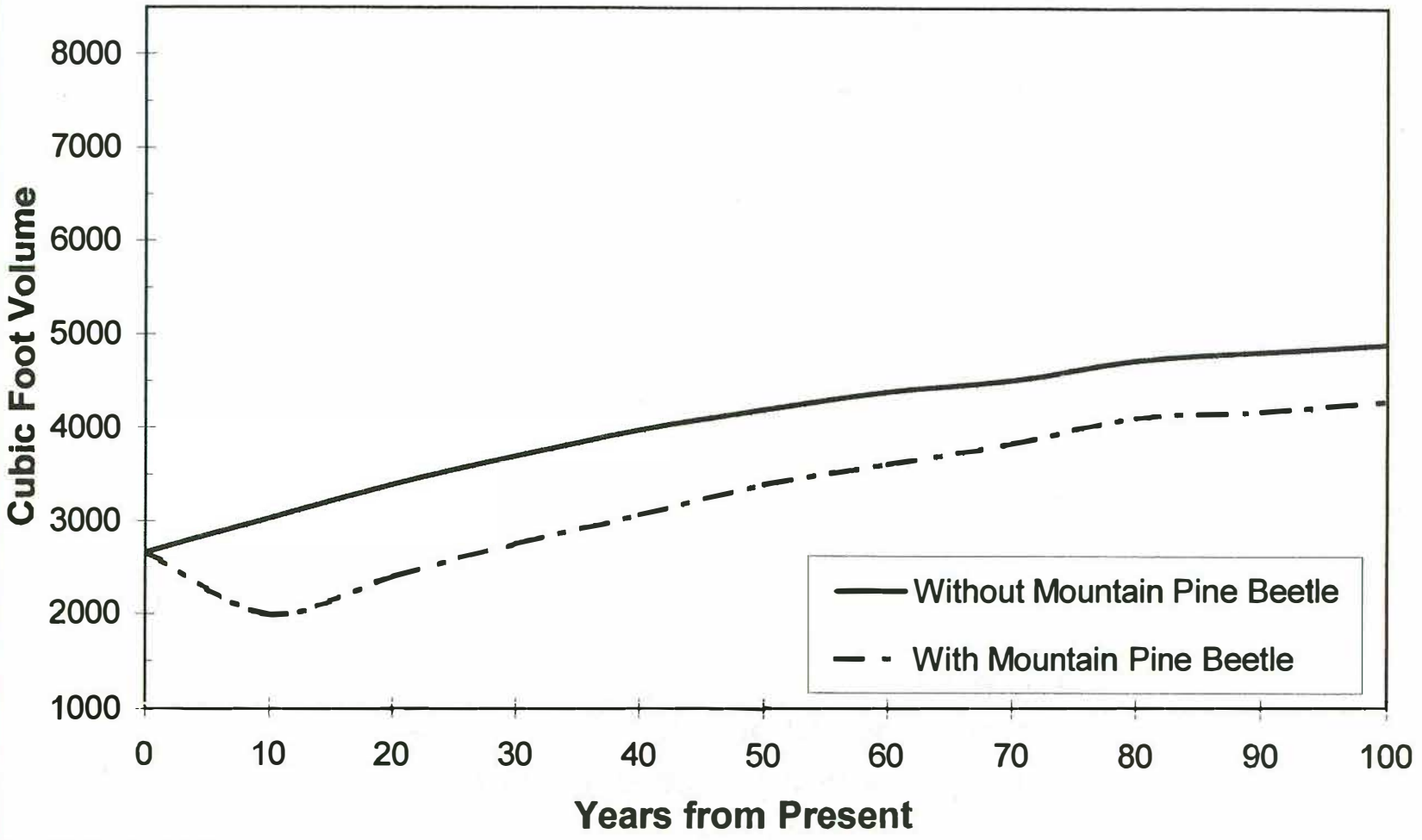


Figure 6
Forest Vegetation Simulator Projection:
impact of mountain pine beetle on cubic volume
[Site 110165-0025, moderate risk]

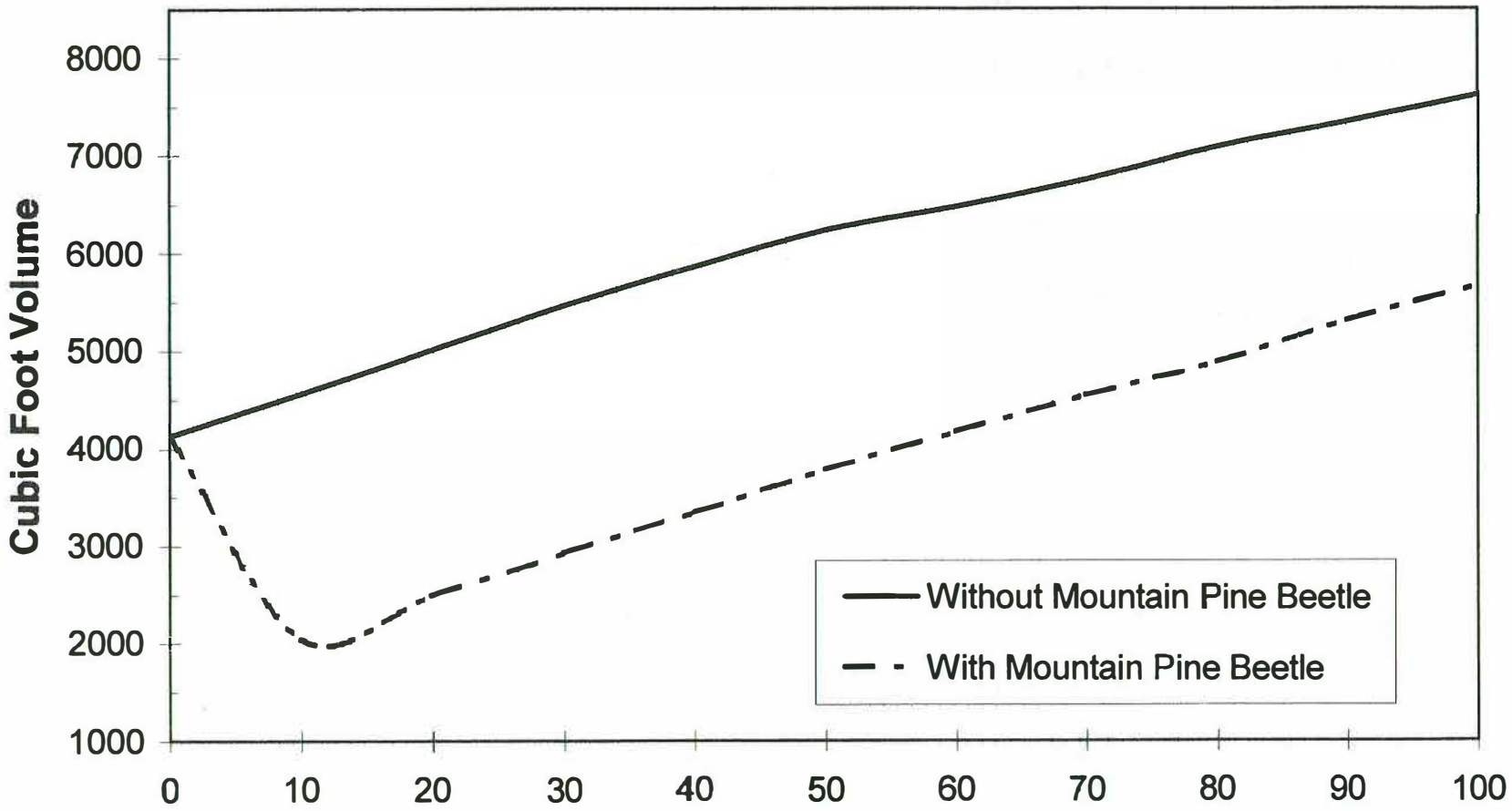


Figure 8
Forest Vegetation Simulator Projection:
impact of dwarf mistletoe on cubic volume
[Site 110177-0016, low mistletoe]

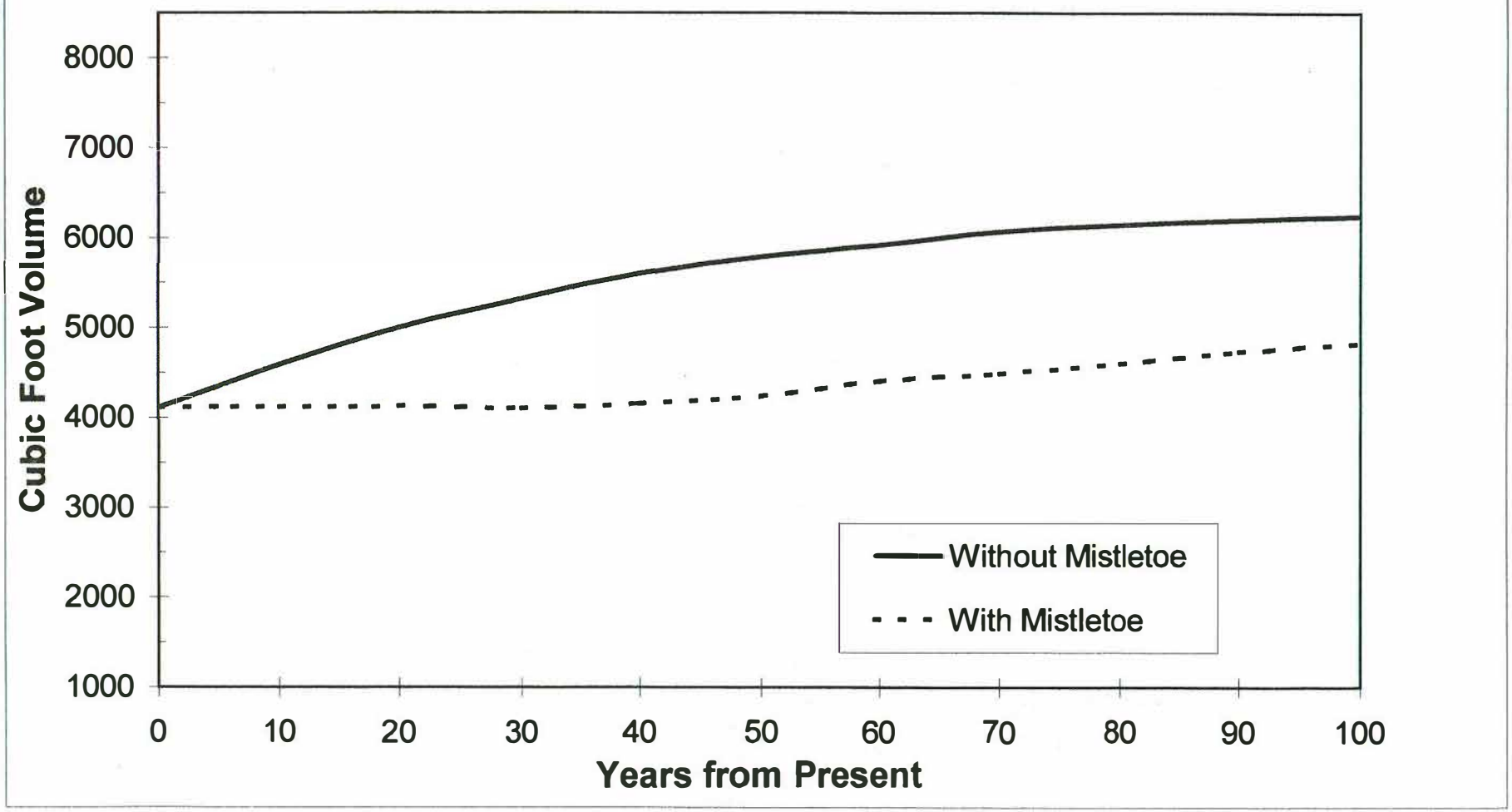


Figure 9
Forest Vegetation Simulator Projection:
impact of dwarf mistletoe on cubic volume
[Site 110143-0072, moderate mistletoe]

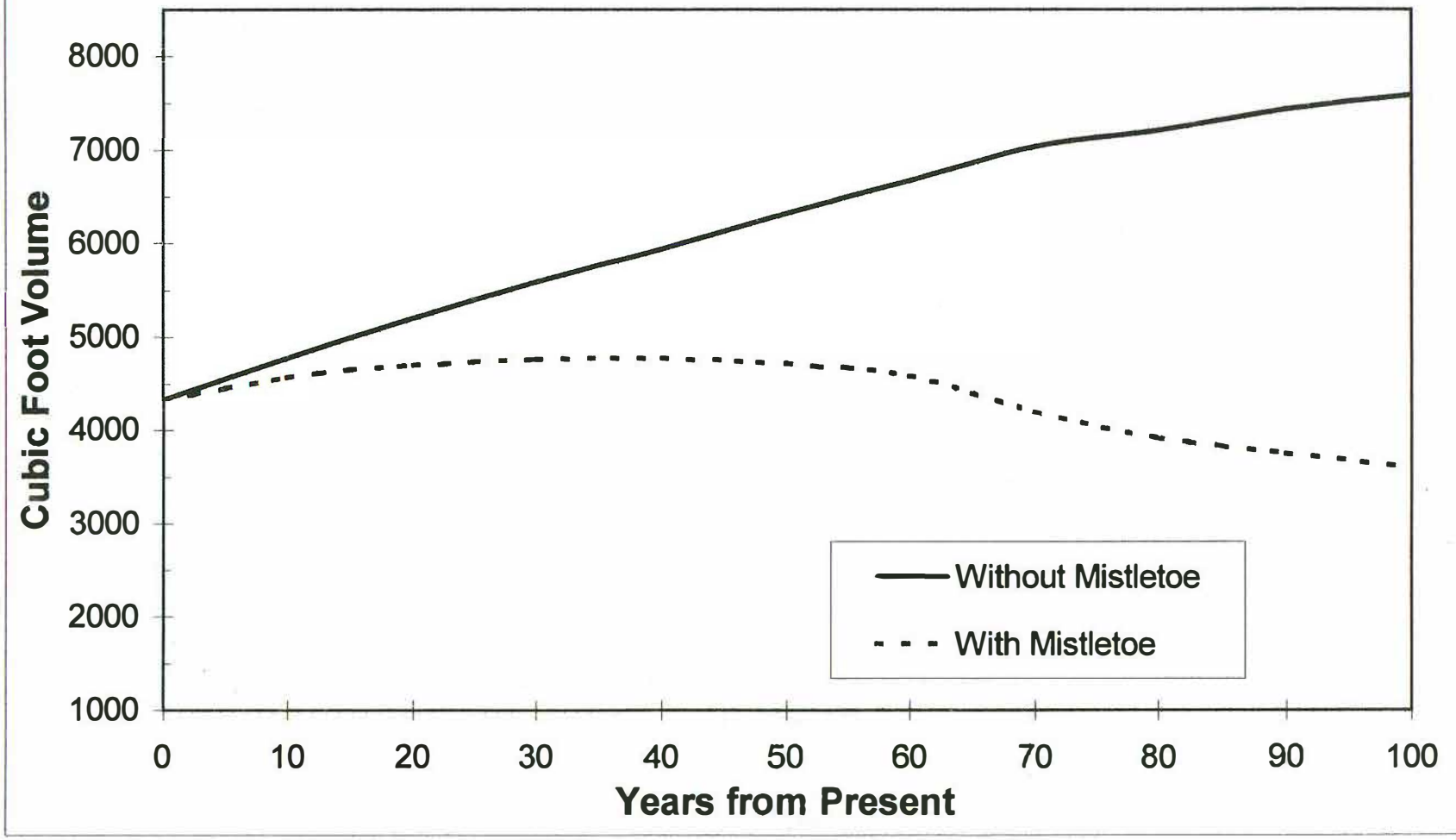


Figure 10
Forest Vegetation Simulator Projection:
impact of dwarf mistletoe on cubic volume
[Site 110143-0080, high mistletoe]

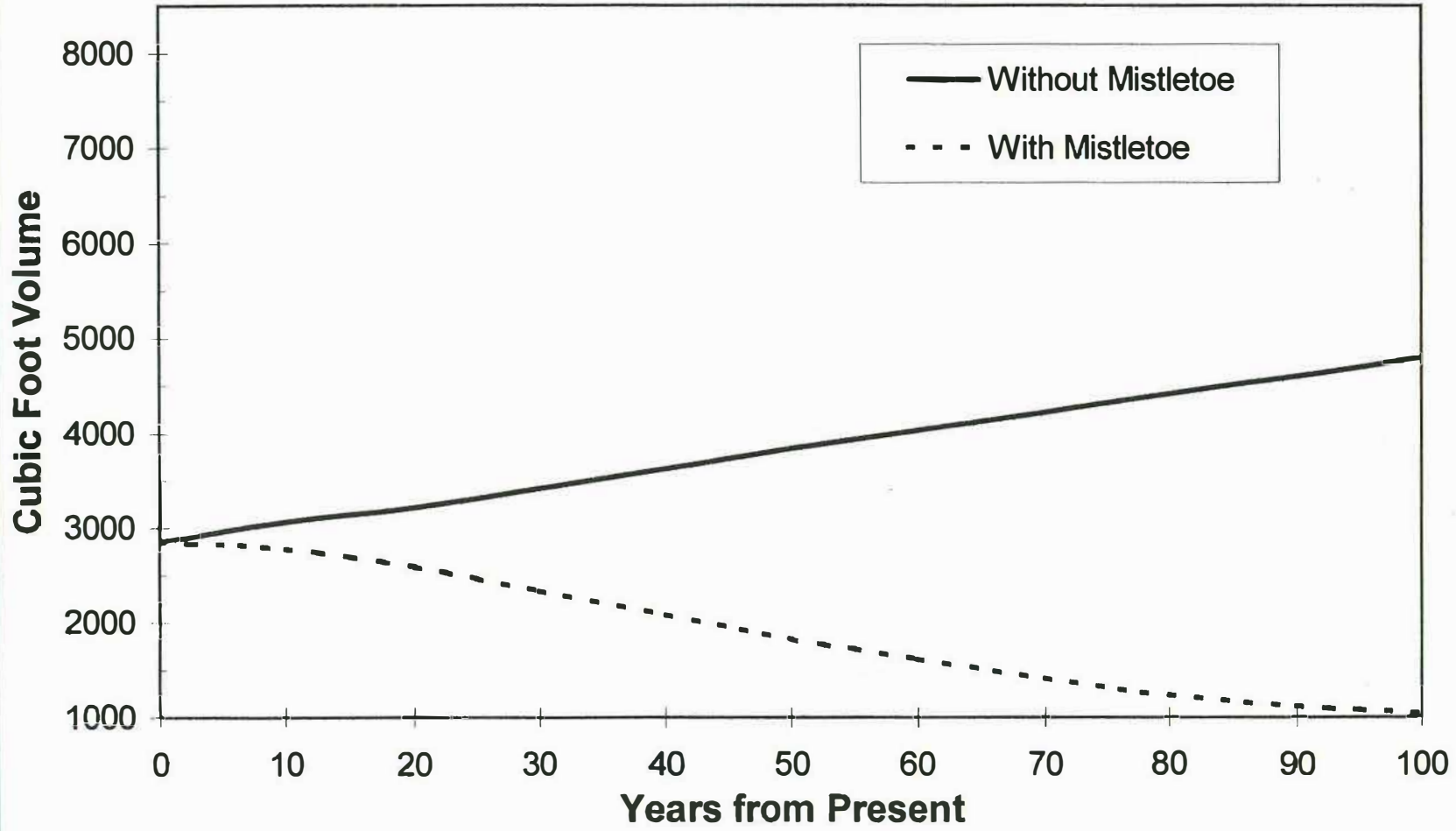
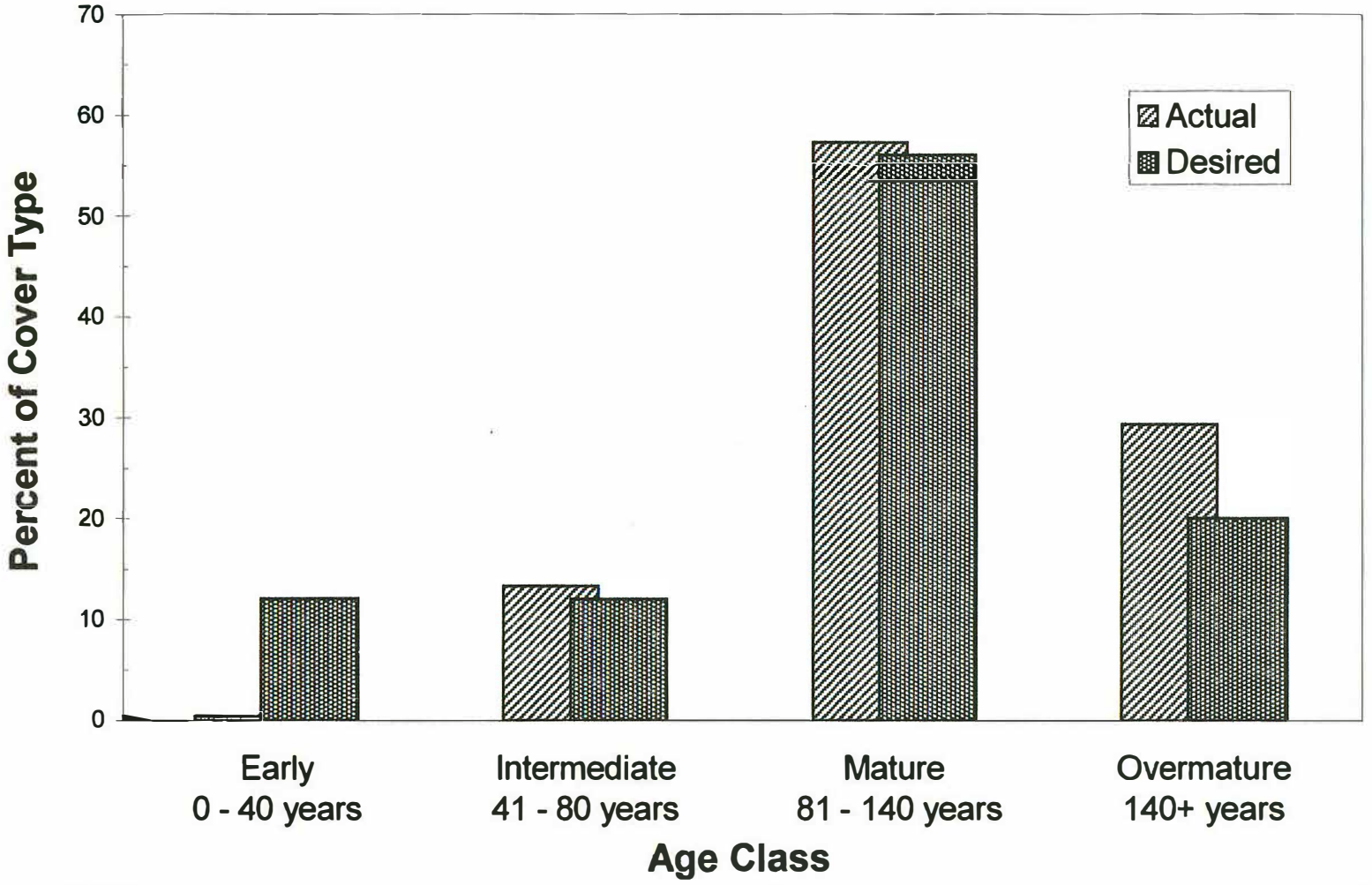


Figure 11
Age Class Distribution: actual versus desired
for inventoried lodgepole pine cover type



APPENDIX A.

APPENDIX A- SUMMARY OF ALL STANDS SURVEYED (1994-96)

COLUMN DEFINITIONS:

LOCATION = RMRIS identifying number.

ELEV = Stand elevation in feet.

ACRES = Stand area in acres.

POINTS = Number of stand exam points surveyed.

TYPE = Forest cover type: AA=Aspen; DF=Douglas-fir; LI=Limber pine;
LP=Lodgepole pine ; PP=Ponderosa pine;
SF=Spruce/fir; unkn=Grass/Forb

AGE = Stand age in years.

STRUC_STAGE = Structural stage of stand.

DMI = Dwarf Mistletoe Intensity; determined for LPP infested trees and calculated by the Stand Exam program:

0	No dwarf mistletoe found
0.1 - 1.99	Light infestation
2.0 - 3.99	Moderate infestation
4.0 - 6.0	Heavy infestation

BRSK = Bark beetle risk rating: For pines: 1 (low); 3 (moderate); 5 (high)
For spruces: 1 (low); 2 (low-medium); 3 (medium); 4 (medium-high)
5 (high)

RUST = Proportion of live LPP trees/acre 5.0 inches dbh and greater with stem cankers.

QMD = Quadradic Mean Diameter of stand x 10.

BA1"+ = Basal Area of trees 1 inches in diameter and greater.

#TREE = Number of trees per acre.

#LRG_TR = Number of large trees 5 inches in diameter and greater per acre.

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110136-0010	7600	5	3	AA	99	3C Sapling Pole	0	0	0.000	92	100	1617	217
110136-0015	7600	6	3	AA	101	4A Mature	0	0	0.000	46	206	3359	659
110136-0019	7800	14	3	AA	93	3B Sapling Pole	0	0	0.000	61	260	6680	880
110136-0028	7800	12	3	AA	94	4B Mature	0	0	0.000	64	216	3080	680
110136-0031	7600	14	3	AA	89	4B Mature	0	0	0.000	78	140	1619	419
110138-0035	8200	6	3	AA	61	3B Sapling Pole	0	0	0.000	50	175	1981	381
110139-0022	8000	8	3	AA	99	4B Mature	0	0	0.000	59	113	2798	298
110139-0034	8400	13	3	AA	16	2 Shrub Seedling	0	0	0.000	70	173	9949	549
110154-0036	8700	12	3	AA	121	3B Sapling Pole	0	0	0.000	50	210	8135	535
110173-0014	8200	74	6	AA	111	3C Sapling Pole	0.3	0	0.000	56	135	2397	197
110136-0013	7600	11	3	DF	118	4C Mature	0	0	0.000	48	142	1835	335
110136-0021	7900	18	3	DF	106	3C Sapling Pole	0	0	0.000	61	124	2716	316
110136-0027	8000	25	3	DF	196	4B Mature	0	0	0.000	57	118	8159	359
110138-0054	8100	7	3	DF	234	3B Sapling Pole	0	0	0.000	65	161	2002	402
110139-0003	8000	7	3	DF	101	4B Mature	0	0	0.000	56	128	2842	242
110139-0017	8000	9	3	DF	122	3C Sapling Pole	0	0	0.000	81	160	2950	250
110145-0032	8600	11	1	DF	229	4B Mature	0	0	0.000	109	73	212	112
110174-0072	8100	5	3	DF	103	4C Mature	0	0	0.000	50	149	2175	375
110175-0037	8200	47	5	DF	118	3C Sapling Pole	0	0	0.000	72	142	2109	309
110158-0011	7900	10	3	DF	114	3C Sapling Pole	0.4	0	0.000	116	120	644	164
110159-0013	7800	11	3	DF	110	3B Sapling Pole	0.5	0	0.000	65	168	3030	530
110174-0013	8200	11	3	DF	115	3C Sapling Pole	0.7	0	0.000	68	178	4915	515
110174-0028	8200	9	3	DF	121	4C Mature	0.9	0	0.000	45	186	4315	475
110136-0022	8000	8	3	LI	104	4 Unknown	0	0	0.000	75	150	1694	494
110136-0033	7900	29	3	LI	157	4 Unknown	0	0	0.000	67	156	2188	338
110139-0039	9000	21	3	LI	49	4 Unknown	0	0	0.000	53	118	1163	363
110158-0014	8000	24	3	LI	91	3 Unknown	0	0	0.000	46	108	5121	221
110145-0030	8600	5	3	LI	114	4 Unknown	0.2	0	0.000	45	98	3250	167
110159-0058	7800	11	3	LI	90	3 Unknown	0.2	0	0.000	73	153	2331	411
110136-0009	7800	9	3	LP	112	3C Sapling Pole	0	1	0.000	68	214	5139	439
110136-0023	8100	15	3	LP	67	3B Sapling Pole	0	1	0.000	54	178	1915	715
110137-0031	8500	54	5	LP	120	4C Mature	0	1	0.000	53	165	2587	687
110137-0032	8500	7	3	LP	61	3B Sapling Pole	0	1	0.000	63	145	3975	375
110137-0034	8400	13	3	LP	73	4B Mature	0	1	0.000	51	131	5284	334
110138-0002	9000	41	3	LP	97	3B Sapling Pole	0	1	0.000	51	103	2517	317
110138-0006	8600	6	3	LP	64	3C Sapling Pole	0	1	0.000	45	155	1526	476

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110138-0009	8400	9	1	LP	67	3A Sapling Pole	0	1	0.000	62	173	3522	522
110138-0012	8100	20	3	LP	66	3C Sapling Pole	0	1	0.000	43	165	2062	562
110138-0014	8200	10	3	LP	62	3C Sapling Pole	0	1	0.000	37	184	3106	606
110138-0025	8600	4	3	LP	65	3C Sapling Pole	0	1	0.000	62	169	1314	314
110138-0031	8300	9	3	LP	61	3B Sapling Pole	0	1	0.000	77	100	1806	306
110138-0036	8500	23	2	LP	65	3C Sapling Pole	0	1	0.000	65	127	1546	446
110138-0044	8200	33	3	LP	65	3C Sapling Pole	0	1	0.000	69	156	802	302
110138-0047	8200	17	3	LP	64	3C Sapling Pole	0	1	0.000	58	294	3595	995
110138-0050	8200	23	3	LP	68	3C Sapling Pole	0	1	0.000	46	130	2407	307
110138-0051	8300	57	3	LP	64	3B Sapling Pole	0	1	0.000	60	134	2296	296
110138-0056	8000	19	3	LP	112	3C Sapling Pole	0	1	0.000	46	144	2750	450
110139-0019	8500	7	3	LP	65	3C Sapling Pole	0	1	0.000	58	140	7421	221
110139-0021	8200	10	3	LP	65	3C Sapling Pole	0	1	0.000	56	122	1123	323
110139-0025	8300	16	3	LP	65	3B Sapling Pole	0	1	0.000	57	146	2319	219
110139-0026	8500	16	3	LP	63	3C Sapling Pole	0	1	0.000	30	97	4125	25
110139-0028	8400	4	3	LP	61	3B Sapling Pole	0	1	0.000	55	89	1945	145
110139-0040	8600	18	3	LP	99	3B Sapling Pole	0	1	0.000	57	42	836	116
110139-0042	8800	42	5	LP	54	3A Sapling Pole	0	1	0.000	72	214	2653	453
110140-0017	8700	17	3	LP	64	3C Sapling Pole	0	1	0.000	107	93	150	150
110141-0002	7600	24	3	LP	105	3C Sapling Pole	0	1	0.000	57	179	3109	309
110141-0006	7800	5	3	LP	110	4C Mature	0	1	0.000	79	193	1971	471
110141-0016	8400	15	3	LP	144	4A Mature	0	1	0.000	44	85	2218	218
110141-0019	8100	14	3	LP	101	3C Sapling Pole	0	1	0.000	56	166	3884	584
110142-0066	8800	6	3	LP	108	3C Sapling Pole	0	1	0.000	57	188	5981	581
110142-0069	9100	9	3	LP	100	3C Sapling Pole	0	1	0.000	69	200	2170	570
110143-0014	8600	5	3	LP	119	3C Sapling Pole	0	1	0.000	53	175	4542	442
110143-0016	8400	15	3	LP	110	3C Sapling Pole	0	1	0.000	50	209	3658	558
110143-0019	8600	24	3	LP	93	3C Sapling Pole	0	1	0.000	73	101	6166	226
110144-0012	9100	17	3	LP	197	4B Mature	0	1	0.000	67	172	3218	287
110145-0036	8600	5	3	LP	119	4C Mature	0	1	0.000	56	161	255	355
110145-0037	8600	2	3	LP	92	3C Sapling Pole	0	1	0.000	94	180	3574	374
110145-0042	8800	15	4	LP	26	2 Shrub Seedling	0	1	0.000	54	159	4498	198
110145-0047	8200	29	3	LP	96	4B Mature	0	1	0.000	41	174	871	271
110146-0017	8200	25	3	LP	75	3C Sapling Pole	0	1	0.000	69	219	8447	347
110146-0021	8300	15	3	LP	67	3B Sapling Pole	0	1	0.000	56	183	5211	471
110146-0027	8300	19	3	LP	68	3C Sapling Pole	0	1	0.000	80	157	6255	255

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110146-0029	8300	23	5	LP	67	3B Sapling Pole	0	1	0.000	66	121	7405	205
110146-0031	8300	35	5	LP	70	3C Sapling Pole	0	1	0.000	64	104	5162	162
110146-0033	8300	6	3	LP	70	3C Sapling Pole	0	1	0.000	63	169	8071	371
110147-0014	8700	41	5	LP	60	3C Sapling Pole	0	1	0.000	60	194	2485	385
110147-0016	8800	15	3	LP	60	3B Sapling Pole	0	1	0.000	52	161	2800	600
110147-0024	8900	9	3	LP	57	3B Sapling Pole	0	1	0.000	69	180	685	685
110147-0028	8500	11	3	LP	51	3A Sapling Pole	0	1	0.000	95	100	6102	202
110147-0029	8500	13	3	LP	57	3B Sapling Pole	0	1	0.000	38	163	6198	298
110147-0040	9000	21	3	LP	69	3B Sapling Pole	0	1	0.000	56	138	3697	297
110147-0048	8900	21	3	LP	71	3C Sapling Pole	0	1	0.000	59	186	4990	690
110159-0046	8200	10	3	LP	94	3B Sapling Pole	0	1	0.000	52	140	1257	477
110161-0004	8500	7	3	LP	36	2 Shrub Seedling	0	1	0.000	68	184	6437	537
110164-0003	8500	14	3	LP	63	3C Sapling Pole	0	1	0.000	54	205	1411	511
110174-0035	8200	24	3	LP	68	3B Sapling Pole	0	1	0.000	43	194	2312	512
110174-0036	8200	5	3	LP	65	3C Sapling Pole	0	1	0.000	52	226	3746	646
110176-0067	8200	11	3	LP	76	3C Sapling Pole	0	1	0.000	47	238	2178	578
110177-0007	8500	20	3	LP	83	3C Sapling Pole	0	1	0.000	51	141	5307	307
110177-0082	8600	20	3	LP	120	3C Sapling Pole	0	1	0.000	43	161	4006	331
110139-0018	8300	8	3	LP	68	3B Sapling Pole	0	1	0.015	58	138	6547	447
110177-0024	8400	43	5	LP	94	3B Sapling Pole	0	1	0.017	71	208	1360	560
110146-0025	7900	37	5	LP	67	3B Sapling Pole	0	1	0.030	53	127	2940	240
110161-0006	8500	13	3	LP	115	3C Sapling Pole	0	1	0.038	67	120	3195	295
110139-0015	8000	14	3	LP	95	3B Sapling Pole	0	1	0.041	40	184	4493	593
110147-0025	8800	22	5	LP	65	3B Sapling Pole	0	1	0.047	77	245	2547	547
110164-0022	8300	15	3	LP	118	4C Mature	0	1	0.055	68	95	2361	261
110144-0014	9800	7	3	LP	179	4C Mature	0	1	0.068	85	150	3277	277
110142-0035	8100	38	5	LP	202	4B Mature	0	1	0.068	62	125	6532	232
110144-0063	8600	4	3	LP	204	4A Mature	0	1	0.072	57	107	1804	404
110145-0034	8500	16	3	LP	113	4B Mature	0	1	0.077	61	271	3421	521
110144-0016	9800	7	3	LP	216	4B Mature	0	1	0.147	69	146	3029	329
110136-0011	7800	16	3	LP	127	3C Sapling Pole	0	3	0.000	70	100	372	372
110136-0012	7800	21	3	LP	141	3B Sapling Pole	0	3	0.000	78	100	605	305
110137-0035	8400	5	3	LP	101	3B Sapling Pole	0	3	0.000	52	161	2384	584
110138-0037	8500	11	1	LP	81	3C Sapling Pole	0	3	0.000	90	147	1230	230
110138-0048	8200	21	3	LP	94	4C Mature	0	3	0.000	111	107	160	160
110139-0008	7700	25	3	LP	100	4B Mature	0	3	0.000	62	108	5020	220

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110139-0016	8100	6	3	LP	276	3B Sapling Pole	0	3	0.000	73	104	1261	261
110139-0024	8100	11	3	LP	106	4B Mature	0	3	0.000	51	45	4011	111
110139-0044	7700	11	3	LP	104	4C Mature	0	3	0.000	48	204	2937	737
110141-0026	8000	28	3	LP	105	4B Mature	0	3	0.000	72	114	1304	204
110142-0040	8100	3	3	LP	124	4B Mature	0	3	0.000	56	157	8533	533
110142-0064	8800	30	5	LP	113	3C Sapling Pole	0	3	0.000	46	210	4750	550
110143-0013	8600	14	3	LP	106	3C Sapling Pole	0	3	0.000	66	182	4436	596
110144-0066	8400	13	3	LP	107	4B Mature	0	3	0.000	58	201	2104	604
110144-0099	8400	7	3	LP	103	3C Sapling Pole	0	3	0.000	74	110	608	308
110147-0038	8900	16	3	LP	99	3C Sapling Pole	0	3	0.000	61	186	8416	416
110161-0002	8500	7	3	LP	179	4A Mature	0	3	0.000	46	129	1894	394
110161-0011	8800	16	3	LP	214	4C Mature	0	3	0.000	70	169	7560	250
110162-0024	8900	3	3	LP	109	3C Sapling Pole	0	3	0.000	60	132	667	367
110162-0033	8600	4	3	LP	111	3C Sapling Pole	0	3	0.000	82	127	841	341
110164-0001	8500	2	3	LP	105	4C Mature	0	3	0.000	59	182	2951	351
110164-0031	8300	16	3	LP	121	3C Sapling Pole	0	3	0.000	66	120	3082	262
110165-0064	8800	14	3	LP	121	3C Sapling Pole	0	3	0.000	75	187	6216	616
110165-0082	8600	8	3	LP	119	3C Sapling Pole	0	3	0.000	58	190	3646	346
110170-0024	8200	48	5	LP	110	3B Sapling Pole	0	3	0.000	69	240	2822	422
110174-0018	8200	18	3	LP	113	3B Sapling Pole	0	3	0.000	77	228	2304	504
110174-0019	8200	8	3	LP	87	3A Sapling Pole	0	3	0.000	58	231	2045	945
110174-0071	8100	6	3	LP	114	4C Mature	0	3	0.000	65	240	1743	643
110177-0012	8300	21	3	LP	97	3C Sapling Pole	0	3	0.000	46	139	3363	413
110177-0080	8600	7	3	LP	117	4A Mature	0	3	0.000	61	189	3015	315
110177-0083	8200	9	3	LP	108	3B Sapling Pole	0	3	0.000	56	126	1242	262
110145-0045	8600	52	5	LP	109	4B Mature	0	3	0.023	47	170	5419	319
110165-0081	8600	6	3	LP	99	4C Mature	0	3	0.029	62	168	7392	292
110141-0007	8000	16	3	LP	113	3C Sapling Pole	0	3	0.030	67	80	527	327
110177-0060	8600	6	3	LP	117	3C Sapling Pole	0	3	0.034	57	118	3766	266
110143-0107	8500	40	5	LP	99	4A Mature	0	3	0.040	72	157	5658	258
110162-0028	8700	22	5	LP	91	4C Mature	0	3	0.050	66	148	824	424
110174-0009	8200	45	5	LP	114	3B Sapling Pole	0	3	0.113	73	170	786	486
110144-0031	8400	84	11	LP	220	4C Mature	0	3	0.140	79	107	2612	312
110143-0109	8500	27	5	LP	115	4B Mature	0	3	0.203	67	164	4264	364
110139-0005	7600	18	3	LP	103	4B Mature	0	5	0.000	77	172	2138	338
110142-0036	8100	8	3	LP	133	4B Mature	0	5	0.000	62	155	2330	330

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110145-0048	8000	5	3	LP	111	4B Mature	0	5	0.000	68	193	302	293
110174-0060	8100	10	3	LP	116	4B Mature	0	5	0.000	71	105	4828	208
110136-0008	7700	8	3	LP	99	4A Mature	0	5	0.050	48	202	2534	434
110138-0030	8300	3	3	LP	75	3C Sapling Pole	0.1	1	0.000	45	111	3811	311
110139-0031	8200	24	3	LP	146	3B Sapling Pole	0.1	1	0.000	74	37	3223	123
110141-0020	8300	39	5	LP	72	3B Sapling Pole	0.1	1	0.000	54	103	945	405
110142-0063	8800	8	3	LP	88	4C Mature	0.1	1	0.000	84	158	4612	312
110142-0065	9000	10	3	LP	122	3C Sapling Pole	0.1	1	0.000	67	115	3574	274
110143-0017	8600	24	3	LP	117	3C Sapling Pole	0.1	1	0.000	61	161	3300	500
110143-0102	8500	4	3	LP	87	3B Sapling Pole	0.1	1	0.000	61	192	2341	441
110147-0001	8300	33	5	LP	63	3B Sapling Pole	0.1	1	0.000	57	124	5191	191
110147-0023	8800	19	3	LP	142	3A Sapling Pole	0.1	1	0.000	64	169	2161	461
110164-0029	8300	9	3	LP	108	3C Sapling Pole	0.1	1	0.000	69	247	1924	544
110165-0047	8600	17	3	LP	124	3B Sapling Pole	0.1	1	0.000	61	175	4160	460
110177-0020	8400	17	3	LP	64	3B Sapling Pole	0.1	1	0.000	63	274	6967	667
110165-0012	8400	17	3	LP	115	3C Sapling Pole	0.1	1	0.022	58	164	1089	589
110147-0022	8700	16	3	LP	56	3C Sapling Pole	0.1	1	0.050	60	196	1898	698
110144-0022	8800	9	3	LP	149	4C Mature	0.1	1	0.080	59	127	4364	364
110137-0030	8500	32	3	LP	162	3C Sapling Pole	0.1	3	0.000	40	69	5702	202
110143-0042	8700	19	3	LP	115	3C Sapling Pole	0.1	3	0.000	39	283	3353	653
110159-0016	7800	8	3	LP	123	4C Mature	0.1	3	0.000	83	197	2725	425
110165-0028	8700	17	3	LP	122	3C Sapling Pole	0.1	3	0.000	117	160	1816	216
110165-0034	8500	17	3	LP	105	4C Mature	0.1	3	0.000	50	168	5686	406
110174-0061	8100	140	15	LP	135	3C Sapling Pole	0.1	3	0.000	61	186	1145	545
110159-0002	8000	78	6	LP	136	3B Sapling Pole	0.1	3	0.026	84	138	1158	258
110144-0054	8700	4	3	LP	221	4A Mature	0.1	3	0.075	61	109	3329	229
110168-0010	8200	32	5	LP	117	4C Mature	0.1	3	0.095	59	120	2810	324
110138-0010	8400	14	2	LP	53	4A Mature	0.2	1	0.000	39	179	3689	489
110173-0026	8200	57	5	LP	115	3C Sapling Pole	0.2	1	0.000	64	169	2730	390
110165-0087	8600	11	3	LP	105	3C Sapling Pole	0.2	1	0.016	75	117	3677	277
110141-0022	8000	13	3	LP	103	3C Sapling Pole	0.2	1	0.055	52	161	1204	404
110174-0059	8100	26	5	LP	105	4B Mature	0.2	1	0.088	70	184	981	581
110138-0060	8500	70	5	LP	120	3C Sapling Pole	0.2	3	0.000	55	180	2706	706
110141-0008	8000	19	3	LP	82	3A Sapling Pole	0.2	3	0.000	71	126	1756	156
110143-0084	8600	26	3	LP	108	3A Sapling Pole	0.2	3	0.000	66	199	1142	542
110159-0006	7800	8	3	LP	96	3B Sapling Pole	0.2	3	0.000	63	103	1314	174

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110141-0011	8000	11	3	LP	90	4B Mature	0.2	3	0.024	54	181	6824	524
110173-0006	8500	62	6	LP	164	4C Mature	0.2	3	0.027	77	203	1122	522
110159-0047	8200	28	5	LP	119	4A Mature	0.2	3	0.035	47	190	1851	551
110144-0055	8400	7	3	LP	211	4C Mature	0.2	3	0.074	64	108	2385	285
110143-0101	8500	20	3	LP	89	4C Mature	0.2	3	0.088	66	171	4319	419
110139-0043	8400	9	3	LP	63	3C Sapling Pole	0.3	1	0.000	79	257	661	461
110141-0014	8000	16	3	LP	108	3C Sapling Pole	0.3	1	0.000	66	170	6609	409
110141-0035	8800	28	3	LP	103	3C Sapling Pole	0.3	1	0.000	46	164	1735	535
110142-0041	8100	24	5	LP	98	3C Sapling Pole	0.3	1	0.000	53	135	3525	405
110143-0036	8700	65	6	LP	79	3C Sapling Pole	0.3	1	0.000	72	243	2256	756
110147-0030	8500	38	5	LP	59	3B Sapling Pole	0.3	1	0.000	154	160	123	123
110168-0015	8200	38	5	LP	130	4B Mature	0.3	1	0.000	60	117	5578	298
110143-0106	8500	27	5	LP	105	3B Sapling Pole	0.3	1	0.035	63	171	7095	295
110144-0023	8600	11	3	LP	229	4C Mature	0.3	1	0.096	99	100	788	188
110137-0028	8500	14	3	LP	237	3C Sapling Pole	0.3	3	0.000	58	158	1058	658
110143-0043	8600	19	3	LP	84	3C Sapling Pole	0.3	3	0.000	44	243	2260	760
110144-0107	8800	9	3	LP	95	3C Sapling Pole	0.3	3	0.000	68	112	2011	211
110162-0029	8700	13	3	LP	212	4C Mature	0.3	3	0.000	66	161	1585	535
110170-0023	8200	5	3	LP	119	4A Mature	0.3	3	0.000	79	87	3452	252
110170-0029	8200	8	3	LP	141	4A Mature	0.3	3	0.000	61	168	3232	332
110174-0020	8200	20	3	LP	101	3B Sapling Pole	0.3	3	0.000	56	200	1589	489
110165-0072	8800	9	3	LP	109	3C Sapling Pole	0.3	3	0.076	52	237	1815	715
110154-0032	8800	14	3	LP	88	4B Mature	0.3	3	0.081	88	20	48	48
110143-0029	8700	60	6	LP	109	3C Sapling Pole	0.4	1	0.000	74	165	2658	358
110147-0021	8700	16	3	LP	70	3C Sapling Pole	0.4	1	0.000	65	120	1594	334
110165-0054	8600	57	6	LP	117	3B Sapling Pole	0.4	1	0.000	57	178	6106	406
110142-0024	8500	9	3	LP	102	3B Sapling Pole	0.4	3	0.000	62	141	3178	278
110147-0049	8900	17	3	LP	243	3C Sapling Pole	0.4	3	0.000	86	131	424	224
110162-0048	7800	7	3	LP	118	3B Sapling Pole	0.4	3	0.000	74	173	1875	375
110165-0080	8600	7	3	LP	165	4B Mature	0.4	3	0.000	38	11	4006	39
110165-0089	8600	10	3	LP	91	3C Sapling Pole	0.4	3	0.015	86	160	497	397
110142-0032	8100	62	5	LP	221	4B Mature	0.4	3	0.017	55	172	6451	417
110140-0015	8700	29	3	LP	205	4C Mature	0.4	3	0.017	56	190	2321	421
110143-0099	8600	20	3	LP	106	3B Sapling Pole	0.4	3	0.020	61	182	2306	606
110138-0053	8100	34	3	LP	103	3B Sapling Pole	0.5	1	0.000	61	210	4033	433
110141-0034	9000	5	3	LP	99	3C Sapling Pole	0.5	1	0.000	70	100	1477	227

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110165-0049	8700	9	3	LP	200	3A Sapling Pole	0.5	1	0.000	59	169	2400	400
110177-0042	9000	90	11	LP	92	3C Sapling Pole	0.5	1	0.041	100	93	569	169
110142-0026	8500	33	5	LP	116	3B Sapling Pole	0.5	1	0.060	42	183	8126	426
110142-0067	8800	5	3	LP	101	3C Sapling Pole	0.5	3	0.000	82	151	5012	312
110143-0085	8600	7	3	LP	120	4B Mature	0.5	3	0.000	60	172	1079	479
110145-0033	8600	12	3	LP	171	4C Mature	0.5	3	0.000	54	134	7656	256
110138-0040	8300	20	3	LP	69	3C Sapling Pole	0.6	1	0.000	106	140	4529	229
110162-0031	8800	74	7	LP	127	4C Mature	0.6	1	0.000	65	114	1394	294
110165-0057	8600	23	3	LP	120	3C Sapling Pole	0.6	1	0.000	69	149	9081	281
110175-0042	7900	26	5	LP	131	3C Sapling Pole	0.6	1	0.032	75	191	2228	328
110142-0025	8500	10	3	LP	110	3C Sapling Pole	0.6	1	0.045	45	225	1422	422
110144-0052	8400	27	3	LP	196	4B Mature	0.6	3	0.000	71	161	3686	286
110177-0011	8700	13	3	LP	119	4C Mature	0.6	3	0.051	55	67	1610	210
110159-0045	8500	33	5	LP	100	3B Sapling Pole	0.7	1	0.000	53	116	1068	368
110173-0011	8500	125	12	LP	172	3C Sapling Pole	0.7	1	0.025	64	188	1634	434
110165-0088	8600	3	3	LP	92	3B Sapling Pole	0.7	1	0.129	81	103	3489	189
110139-0027	8300	9	3	LP	114	4A Mature	0.7	3	0.000	58	137	4159	259
110141-0017	8200	6	3	LP	112	4B Mature	0.7	3	0.000	84	173	4253	453
110177-0059	9000	80	9	LP	117	3C Sapling Pole	0.7	3	0.000	71	201	830	630
110142-0029	8500	58	5	LP	105	3B Sapling Pole	0.7	3	0.017	64	165	7328	428
110141-0018	8200	25	3	LP	97	3B Sapling Pole	0.7	3	0.080	63	120	2257	257
110143-0026	8400	13	3	LP	33	2 Shrub Seedling	0.8	1	0.000	52	142	3056	256
110144-0062	8400	12	3	LP	203	4B Mature	0.8	1	0.000	75	203	1064	464
110165-0076	8600	30	5	LP	106	3C Sapling Pole	0.8	1	0.000	36	26	4523	56
110165-0059	8700	32	5	LP	112	3C Sapling Pole	0.8	1	0.020	64	121	5540	240
110167-0001	7900	156	14	LP	129	3B Sapling Pole	0.8	1	0.040	55	88	2327	227
110165-0045	8600	19	3	LP	123	3C Sapling Pole	0.8	1	0.065	54	136	4750	350
110148-0027	8900	10	3	LP	193	4B Mature	0.8	1	0.091	51	32	455	55
110158-0016	8000	6	3	LP	108	3B Sapling Pole	0.8	3	0.000	59	108	864	264
110162-0021	8700	18	3	LP	134	4C Mature	0.8	3	0.000	80	99	1882	182
110165-0025	8600	51	5	LP	118	3C Sapling Pole	0.8	3	0.000	64	24	241	41
110177-0078	8600	16	3	LP	118	3C Sapling Pole	0.8	3	0.017	51	131	4475	382
110141-0027	8400	32	3	LP	117	3B Sapling Pole	0.8	3	0.051	79	158	2569	269
110144-0108	8800	7	3	LP	107	3C Sapling Pole	0.8	3	0.107	66	187	6066	306
110165-0033	8600	15	3	LP	102	3B Sapling Pole	0.9	1	0.000	70	167	1158	438
110174-0026	8000	66	3	LP	65	4B Mature	0.9	1	0.000	96	130	1356	256

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110143-0047	8700	14	3	LP	181	3C Sapling Pole	0.9	3	0.000	50	210	1922	622
110158-0010	7900	14	3	LP	95	4A Mature	0.9	3	0.000	74	144	1022	242
110160-0031	8700	17	3	LP	161	4B Mature	0.9	3	0.000	45	120	4117	217
110177-0056	8700	47	7	LP	141	4B Mature	0.9	3	0.000	75	268	3781	781
110161-0018	8600	11	3	LP	99	4B Mature	0.9	3	0.045	46	153	9932	332
110177-0032	9000	4	3	LP	133	4A Mature	0.9	3	0.046	65	189	2315	415
110160-0024	8800	30	5	LP	148	4C Mature	0.9	3	0.061	51	142	1006	526
110165-0060	8700	6	3	LP	128	3C Sapling Pole	0.9	3	0.077	51	196	367	367
110165-0029	8600	27	3	LP	113	4B Mature	0.9	3	0.142	61	125	1719	219
110139-0032	8200	21	3	LP	63	3A Sapling Pole	1	1	0.000	46	131	3029	229
110139-0011	7900	11	3	LP	260	3C Sapling Pole	1	1	0.049	46	134	1741	541
110138-0001	9000	151	6	LP	103	4B Mature	1	3	0.000	47	130	5574	474
110141-0036	8600	9	3	LP	104	3C Sapling Pole	1	3	0.000	49	164	2951	351
110143-0046	8600	10	3	LP	189	4C Mature	1	3	0.000	53	187	1420	520
110143-0024	8400	14	3	LP	102	3C Sapling Pole	1	3	0.041	72	169	6995	295
110143-0010	9100	13	3	LP	181	4B Mature	1	3	0.183	59	175	1918	418
110138-0003	8800	44	6	LP	222	4B Mature	1.1	1	0.000	42	199	3730	430
110138-0034	8200	26	3	LP	63	3C Sapling Pole	1.1	1	0.000	60	193	2108	668
110164-0007	8300	10	3	LP	116	3C Sapling Pole	1.1	1	0.000	58	121	1436	296
110177-0041	9000	24	5	LP	80	3A Sapling Pole	1.1	1	0.000	56	181	1187	647
110165-0015	8600	4	3	LP	115	4B Mature	1.1	1	0.059	73	205	3705	405
110144-0015	9000	26	3	LP	206	4C Mature	1.1	1	0.130	68	162	2509	409
110141-0021	8000	5	3	LP	96	3C Sapling Pole	1.1	3	0.000	61	210	1339	639
110144-0098	8400	29	5	LP	109	3B Sapling Pole	1.1	3	0.011	48	126	2801	341
110171-0021	8100	87	8	LP	196	4C Mature	1.1	3	0.025	85	166	2421	221
110164-0025	8300	11	3	LP	220	4B Mature	1.1	3	0.041	71	170	4126	426
110161-0022	8700	29	3	LP	107	4B Mature	1.1	3	0.085	65	206	5292	392
110161-0017	8600	4	3	LP	123	4A Mature	1.1	3	0.157	60	171	2569	669
110142-0057	8800	8	3	LP	121	4C Mature	1.2	1	0.000	68	124	7387	247
110174-0046	8300	82	9	LP	109	3B Sapling Pole	1.2	1	0.000	57	188	2088	528
110164-0024	8300	50	5	LP	106	3C Sapling Pole	1.2	1	0.025	73	150	1310	510
110144-0065	8400	3	3	LP	104	3C Sapling Pole	1.2	1	0.061	66	188	6258	438
110141-0030	8800	56	6	LP	150	4A Mature	1.2	3	0.000	82	120	726	326
110143-0003	8700	5	3	LP	210	4B Mature	1.2	3	0.000	55	155	2324	424
110143-0045	8500	15	3	LP	114	3C Sapling Pole	1.2	3	0.000	59	266	1411	811
110161-0026	8700	9	3	LP	105	4B Mature	1.2	3	0.000	56	176	8815	415

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110141-0023	8300	6	3	LP	113	3B Sapling Pole	1.2	3	0.092	68	151	1305	405
110143-0021	8700	14	3	LP	108	3C Sapling Pole	1.3	1	0.000	89	150	1247	347
110143-0105	8500	12	3	LP	112	3C Sapling Pole	1.3	1	0.000	80	115	3726	226
110174-0056	8100	3	3	LP	71	3C Sapling Pole	1.3	1	0.000	56	110	1037	237
110142-0056	9000	6	3	LP	157	3C Sapling Pole	1.3	1	0.022	50	122	3384	284
110145-0031	8600	5	3	LP	115	3C Sapling Pole	1.3	1	0.032	56	140	6321	221
110161-0007	8500	18	3	LP	113	3C Sapling Pole	1.3	3	0.000	78	150	758	458
110142-0023	8500	41	5	LP	213	4B Mature	1.3	3	0.140	51	146	1410	330
110177-0018	8700	10	3	LP	73	3B Sapling Pole	1.4	1	0.000	53	178	2244	564
110177-0016	9000	39	5	LP	124	4C Mature	1.4	1	0.066	38	190	4454	354
110160-0056	8900	7	3	LP	116	4B Mature	1.4	3	0.030	50	122	2530	430
110139-0001	8500	11	3	LP	98	3B Sapling Pole	1.4	3	0.044	44	158	3681	481
110177-0014	8700	37	5	LP	123	3B Sapling Pole	1.4	3	0.047	43	208	7328	428
110177-0030	8800	9	3	LP	190	4C Mature	1.4	3	0.063	71	134	5282	282
110139-0033	8400	24	3	LP	165	4B Mature	1.5	1	0.000	55	157	3261	361
110142-0058	8800	27	5	LP	114	3C Sapling Pole	1.5	1	0.000	53	142	4640	260
110161-0035	8800	65	7	LP	107	3B Sapling Pole	1.5	1	0.031	50	121	7390	190
110143-0075	8600	11	3	LP	259	3B Sapling Pole	1.5	1	0.209	56	179	2198	448
110174-0049	8200	7	3	LP	115	4B Mature	1.5	3	0.000	59	191	1008	508
110142-0004	8600	99	10	LP	112	3B Sapling Pole	1.6	1	0.000	68	182	1711	511
110160-0039	8600	12	3	LP	207	4B Mature	1.6	1	0.065	52	195	1738	718
110143-0069	8600	140	13	LP	211	4C Mature	1.6	3	0.000	54	188	1681	481
110162-0020	8700	17	3	LP	109	4B Mature	1.6	3	0.000	60	125	2236	336
110162-0022	8700	50	6	LP	149	4C Mature	1.6	3	0.000	69	193	840	540
110175-0030	8200	54	5	LP	119	3B Sapling Pole	1.6	3	0.000	69	113	2335	235
110166-0040	8100	70	6	LP	112	3C Sapling Pole	1.7	1	0.000	62	135	3851	351
110160-0047	8900	8	3	LP	190	4B Mature	1.7	1	0.047	37	218	4868	468
110138-0027	8500	11	3	LP	194	3B Sapling Pole	1.7	3	0.000	41	251	4319	719
110160-0028	8800	34	5	LP	130	4B Mature	1.7	3	0.000	50	133	2610	510
110175-0029	8000	35	5	LP	119	4B Mature	1.7	3	0.000	62	233	4716	716
110174-0017	8200	70	7	LP	116	3B Sapling Pole	1.7	3	0.041	72	153	2233	433
110138-0005	8800	77	5	LP	120	3B Sapling Pole	1.8	3	0.000	46	121	2447	347
110162-0026	8800	20	3	LP	170	4C Mature	1.8	3	0.029	51	218	5468	468
110174-0047	8300	20	5	LP	121	3B Sapling Pole	1.8	3	0.049	64	149	666	366
110143-0004	8700	14	3	LP	250	4B Mature	1.9	1	0.000	57	167	6177	477
110161-0009	8500	40	5	LP	228	4B Mature	1.9	1	0.000	81	154	1451	311

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110170-0027	8200	52	5	LP	236	3C Sapling Pole	1.9	1	0.000	76	225	7620	420
110147-0020	8700	49	5	LP	211	3C Sapling Pole	1.9	1	0.052	70	155	1473	373
110147-0008	8200	63	6	LP	188	4B Mature	1.9	1	0.112	59	102	1434	134
110142-0053	9000	20	3	LP	111	3C Sapling Pole	1.9	3	0.000	60	123	5310	330
110165-0017	8400	6	3	LP	117	4C Mature	1.9	3	0.037	69	156	3205	305
110159-0041	8200	29	3	LP	112	3C Sapling Pole	2	1	0.000	75	232	7552	352
110177-0085	8300	27	5	LP	162	3A Sapling Pole	2	1	0.000	57	160	7901	501
110174-0057	8100	24	5	LP	194	3B Sapling Pole	2	3	0.022	68	185	842	342
110164-0010	8400	21	3	LP	108	4B Mature	2	3	0.046	51	134	6878	338
110143-0020	8800	27	3	LP	174	4C Mature	2	3	0.161	68	145	2866	366
110159-0017	7600	19	3	LP	115	4C Mature	2.1	1	0.000	104	100	171	171
110170-0026	8200	8	3	LP	129	3C Sapling Pole	2.1	1	0.000	72	163	876	376
110147-0043	8600	110	11	LP	201	4C Mature	2.1	3	0.000	51	161	1845	345
110165-0078	8500	8	3	LP	206	4A Mature	2.1	3	0.000	51	133	3097	217
110160-0052	8900	17	3	LP	116	4C Mature	2.2	1	0.000	49	106	1922	322
110161-0001	8500	6	3	LP	129	4A Mature	2.2	3	0.020	53	149	2665	365
110177-0076	8300	4	3	LP	157	4C Mature	2.3	1	0.068	57	156	1386	386
110143-0061	8700	17	3	LP	171	4A Mature	2.3	3	0.068	69	178	2479	379
110139-0041	8400	11	3	LP	168	4C Mature	2.4	1	0.000	45	172	2063	463
110160-0049	8900	53	6	LP	104	3C Sapling Pole	2.4	1	0.000	56	96	3973	273
110165-0095	8800	6	3	LP	135	4C Mature	2.4	1	0.057	46	148	8968	268
110160-0027	8800	6	3	LP	112	3C Sapling Pole	2.4	1	0.071	43	197	2083	483
110143-0001	9000	43	5	LP	243	4A Mature	2.4	3	0.000	52	205	3286	586
110143-0022	8400	4	3	LP	177	3C Sapling Pole	2.4	3	0.000	51	106	9450	250
110143-0027	8400	11	3	LP	262	3B Sapling Pole	2.4	3	0.000	50	198	4595	515
110161-0039	8800	26	5	LP	232	4B Mature	2.4	3	0.000	48	168	7987	307
110174-0055	8100	10	3	LP	130	3A Sapling Pole	2.4	3	0.000	60	160	1612	612
110143-0070	8600	16	3	LP	125	4B Mature	2.4	3	0.113	40	26	364	64
110138-0033	8200	5	3	LP	70	3B Sapling Pole	2.5	1	0.000	44	167	3363	363
110168-0013	8200	90	8	LP	142	3C Sapling Pole	2.5	1	0.030	66	141	3394	294
110160-0029	8700	10	3	LP	253	4C Mature	2.5	3	0.000	58	118	4253	253
110143-0074	8600	41	4	LP	156	4B Mature	2.5	3	0.085	53	187	5269	619
110143-0062	8700	27	3	LP	165	4C Mature	2.5	3	0.384	54	181	4257	657
110177-0037	9000	10	3	LP	235	4C Mature	2.6	1	0.019	91	92	2965	205
110174-0052	8300	40	6	LP	107	3C Sapling Pole	2.6	1	0.021	38	227	3016	349
110161-0015	8800	32	5	LP	182	4C Mature	2.6	3	0.000	50	186	2136	636

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110174-0014	8300	21	3	LP	112	4B Mature	2.6	3	0.000	55	227	5007	464
110177-0065	8300	21	3	LP	115	4C Mature	2.6	3	0.000	50	267	2637	637
110165-0071	8800	3	3	LP	108	3C Sapling Pole	2.6	3	0.067	50	41	932	99
110165-0014	8700	4	3	LP	103	3C Sapling Pole	2.7	3	0.000	64	144	3335	275
110160-0026	8800	35	5	LP	111	4B Mature	2.7	3	0.022	45	172	1708	508
110160-0048	8900	10	3	LP	251	3C Sapling Pole	2.7	3	0.042	38	177	4143	543
110143-0072	8600	41	4	LP	113	4B Mature	2.7	3	0.174	49	115	2474	274
110165-0055	8600	20	3	LP	103	3C Sapling Pole	2.8	1	0.000	70	177	3658	258
110174-0051	8400	30	5	LP	134	3C Sapling Pole	2.8	3	0.031	65	193	1730	530
110160-0059	8900	4	3	LP	104	3C Sapling Pole	2.8	3	0.100	61	101	999	399
110164-0012	8400	9	3	LP	155	3C Sapling Pole	2.9	1	0.000	47	126	1660	360
110143-0067	8600	8	3	LP	264	4C Mature	2.9	3	0.000	68	184	2341	541
110165-0091	8600	14	3	LP	128	4B Mature	2.9	3	0.124	59	155	2990	333
110177-0035	9000	31	5	LP	155	4C Mature	2.9	3	0.152	74	171	574	474
110177-0045	8800	18	3	LP	70	3C Sapling Pole	3	1	0.065	95	150	1506	306
110160-0040	8600	12	3	LP	250	4B Mature	3.2	3	0.032	53	133	1766	466
110165-0085	8600	20	3	LP	186	4B Mature	3.2	3	0.042	63	180	4984	484
110175-0032	8200	21	3	LP	119	3C Sapling Pole	3.2	3	0.096	59	154	2122	622
110177-0068	8600	34	5	LP	105	3C Sapling Pole	3.3	1	0.025	48	140	2897	297
110165-0070	8800	7	3	LP	118	4C Mature	3.3	3	0.037	94	96	3000	100
110160-0043	8900	36	5	LP	113	4C Mature	3.5	3	0.057	56	172	4844	404
110161-0041	8800	13	3	LP	108	3A Sapling Pole	3.5	3	0.202	63	117	2544	244
110174-0015	8300	10	3	LP	120	3B Sapling Pole	3.6	1	0.000	63	250	1159	859
110177-0077	8500	37	6	LP	139	3B Sapling Pole	3.6	3	0.031	48	166	7459	409
110177-0017	8700	42	5	LP	194	4B Mature	3.6	3	0.088	42	193	4623	523
110165-0027	8600	26	3	LP	118	3C Sapling Pole	3.7	3	0.000	59	128	3868	168
110177-0073	8600	57	7	LP	158	4B Mature	3.7	3	0.000	60	162	814	614
110177-0074	8600	39	5	LP	187	4B Mature	3.8	3	0.000	83	173	1658	358
110165-0075	8600	35	5	LP	179	4A Mature	3.8	3	0.044	63	268	4544	844
110165-0019	8400	23	3	LP	110	3C Sapling Pole	3.9	3	0.000	77	161	2402	402
110159-0042	8500	56	5	LP	130	3B Sapling Pole	4	1	0.046	29	222	7187	387
110160-0041	8600	3	3	LP	265	4B Mature	4	3	0.000	76	156	3498	318
110165-0068	8800	6	3	LP	167	4B Mature	4	3	0.104	62	80	3477	177
110143-0080	8600	18	3	LP	162	4A Mature	4	3	0.268	53	165	4901	401
110177-0063	8300	16	3	LP	142	3C Sapling Pole	4.1	1	0.067	62	127	2211	211
110165-0093	8600	13	3	LP	174	4A Mature	4.1	3	0.055	84	120	3209	309

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110143-0018	8600	23	3	LP	137	3C Sapling Pole	4.3	1	0.000	52	176	2017	517
110177-0036	9000	20	3	LP	179	4B Mature	4.6	3	0.234	63	261	1311	911
110177-0075	8600	43	5	LP	198	4C Mature	4.9	1	0.000	70	109	3107	207
110138-0029	8500	17	2	LP	201	3B Sapling Pole	5	1	0.000	41	98	4520	253
110145-0040	8800	32	3	LP	117	4B Mature	?	3	0.000	57	200	9632	232
110136-0030	7900	16	3	PP	167	4C Mature	0	3	0.000	64	159	3295	535
110141-0025	8000	18	3	PP	97	4B Mature	0	3	0.000	61	166	389	376
110145-0051	8000	20	5	PP	116	4B Mature	0	3	0.000	70	214	2241	541
110136-0029	7800	21	3	PP	117	4C Mature	0	5	0.000	76	113	460	260
110136-0036	7700	50	5	PP	137	4B Mature	0	5	0.000	48	179	1400	400
110139-0014	7800	22	3	PP	156	4B Mature	0	5	0.000	59	224	2973	693
110141-0003	7700	13	3	PP	157	4B Mature	0	5	0.000	75	102	631	231
110145-0053	8000	7	3	PP	106	4C Mature	0	5	0.000	56	173	8199	449
110145-0055	7900	6	3	PP	137	4B Mature	0	5	0.000	52	373	5646	1796
110144-0049	8400	8	3	SF	108	4B Mature	0	1	0.000	67	161	7434	414
110161-0008	8500	10	3	SF	34	2 Shrub Seedling	0	1	0.000	48	92	1400	260
110161-0010	8800	2	3	SF	28	2 Shrub Seedling	0	1	0.000	56	173	3829	502
110165-0056	8600	21	3	SF	205	3C Sapling Pole	0	1	0.000	59	177	1599	399
110168-0019	7800	22	3	SF	116	3B Sapling Pole	0	1	0.000	64	142	2585	385
110173-0018	8600	19	3	SF	112	3B Sapling Pole	0	1	0.000	67	284	1379	979
110142-0018	8500	5	3	SF	154	3C Sapling Pole	0	2	0.000	76	105	433	333
110138-0008	8500	5	3	SF	105	4C Mature	0	3	0.000	67	164	4808	368
110142-0015	8500	12	3	SF	214	4B Mature	0	3	0.000	67	147	1119	391
110142-0042	8100	8	3	SF	123	4B Mature	0	3	0.000	49	152	1874	474
110144-0011	9800	4	3	SF	167	4B Mature	0	3	0.000	47	117	7291	271
110144-0020	9800	16	3	SF	171	4C Mature	0	3	0.000	102	170	5400	300
110147-0041	8900	31	5	SF	162	4B Mature	0	3	0.000	69	173	1371	571
110148-0018	8700	11	3	SF	126	4C Mature	0	3	0.000	51	206	3713	413
110148-0021	8900	10	3	SF	225	4C Mature	0	3	0.000	76	141	1950	270
110160-0055	8500	9	3	SF	132	4B Mature	0	3	0.000	73	147	4604	304
110162-0023	8800	13	3	SF	107	4B Mature	0	3	0.000	67	146	1404	376
110144-0032	8400	26	3	SF	229	4C Mature	0	4	0.000	67	202	4523	423
110158-0015	8000	9	3	SF	90	3C Sapling Pole	0.1	1	0.000	53	142	1344	744
110144-0010	9800	35	5	SF	223	4C Mature	0.1	2	0.000	60	126	6691	331
110161-0025	8700	4	3	SF	104	3B Sapling Pole	0.1	2	0.000	68	217	869	769
110139-0030	8400	50	5	SF	132	4B Mature	0.1	3	0.000	60	116	941	341

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110142-0017	8500	4	3	SF	254	3C Sapling Pole	0.1	3	0.000	67	128	716	316
110142-0030	8400	5	3	SF	127	4B Mature	0.1	3	0.000	69	212	1008	408
110145-0029	8600	6	3	SF	118	4C Mature	0.1	3	0.000	57	203	1561	481
110160-0023	9100	13	3	SF	126	4B Mature	0.2	1	0.000	53	141	1147	307
110142-0038	8100	17	3	SF	207	3C Sapling Pole	0.2	3	0.000	45	143	1881	481
110143-0007	8900	25	5	SF	184	3C Sapling Pole	0.2	3	0.000	66	297	4032	732
110143-0064	8700	7	3	SF	181	4B Mature	0.2	3	0.000	47	151	7808	358
110148-0017	8700	4	3	SF	188	3B Sapling Pole	0.2	3	0.000	69	163	859	439
110173-0025	8200	37	5	SF	184	4B Mature	0.2	3	0.000	79	103	905	205
110161-0037	8800	9	3	SF	125	4B Mature	0.3	1	0.000	74	235	778	578
110147-0004	8200	7	3	SF	233	4B Mature	0.3	2	0.000	49	183	1727	527
110161-0020	8700	71	7	SF	156	4B Mature	0.3	3	0.000	69	180	768	535
110141-0015	8400	14	3	SF	112	3B Sapling Pole	0.4	3	0.000	54	146	1119	319
110143-0104	8500	43	5	SF	189	4C Mature	0.4	3	0.000	46	152	4030	430
110144-0036	9800	51	5	SF	149	3C Sapling Pole	0.4	3	0.000	38	140	7942	242
110144-0064	8700	20	3	SF	214	4C Mature	0.4	3	0.000	69	188	2325	525
110148-0028	8900	36	5	SF	203	4C Mature	0.4	3	0.000	53	112	729	329
110160-0054	8900	7	3	SF	122	4B Mature	0.4	3	0.000	80	173	2178	318
110144-0025	8400	20	3	SF	223	3C Sapling Pole	0.5	3	0.000	61	167	2407	407
110144-0053	8400	10	3	SF	173	4B Mature	0.5	3	0.000	64	132	831	351
110139-0037	8600	4	3	SF	158	4A Mature	0.6	1	0.000	61	149	1528	328
110160-0030	8700	7	3	SF	100	4B Mature	0.6	1	0.000	67	233	5858	458
110165-0024	8500	24	5	SF	129	4A Mature	0.6	2	0.000	88	170	6279	339
110147-0019	8900	37	5	SF	181	4B Mature	0.6	3	0.000	54	175	1602	502
110161-0027	8800	7	3	SF	186	3A Sapling Pole	0.8	2	0.000	54	259	2738	538
110143-0098	8600	17	3	SF	115	4A Mature	0.9	1	0.000	65	90	798	198
110143-0037	8700	30	5	SF	267	4C Mature	0.9	2	0.000	60	162	6897	477
110139-0035	8500	12	3	SF	195	4B Mature	0.9	3	0.000	55	249	1799	1199
110142-0019	8500	76	8	SF	144	3B Sapling Pole	0.9	3	0.000	60	109	857	357
110146-0005	8700	17	3	SF	165	4C Mature	0.9	3	0.000	46	170	2281	421
110143-0002	9000	11	3	SF	207	3B Sapling Pole	1	1	0.000	52	127	1514	347
110165-0084	8800	16	3	SF	185	4B Mature	1	2	0.000	59	164	4369	369
110138-0024	8400	38	3	SF	119	3A Sapling Pole	1	3	0.000	52	191	4348	688
110142-0022	8500	101	9	SF	180	4C Mature	1	3	0.000	44	139	3695	295
110161-0042	8800	21	3	SF	223	4C Mature	1	3	0.000	43	261	2564	764
110143-0005	8700	8	3	SF	204	4B Mature	1.1	3	0.000	60	141	2706	486

LOCATION	ELEV	ACRES	POINTS	TYPE	AGE	STRUC_STAGE	DMI	BRSK	RUST	QMD	BA1"+	#TREE	#LRG_TR
110161-0013	8800	23	3	SF	244	4C Mature	1.2	3	0.000	45	178	1604	504
110160-0045	8900	29	5	SF	166	3C Sapling Pole	1.3	1	0.000	84	108	480	180
110147-0039	8900	5	3	SF	215	4B Mature	1.4	2	0.000	66	228	1853	453
110161-0016	8600	6	3	SF	195	3A Sapling Pole	1.5	1	0.000	76	148	1066	338
110143-0006	9100	27	3	SF	251	4B Mature	1.5	2	0.000	63	128	1782	282
110138-0004	8400	27	3	SF	128	3B Sapling Pole	1.5	3	0.000	47	108	1913	313
110174-0050	8000	10	3	SF	131	3C Sapling Pole	1.6	1	0.000	57	251	1417	1017
110160-0057	8900	19	3	SF	122	4C Mature	2.5	1	0.000	55	160	2561	361
110145-0043	8800	4	1	unkn	0	1 Grass Forb	0	0	0.000	66	153	748	448
110160-0038	8600	4	3	unkn	0	1 Grass Forb	0	0	0.000	56	99	1543	223

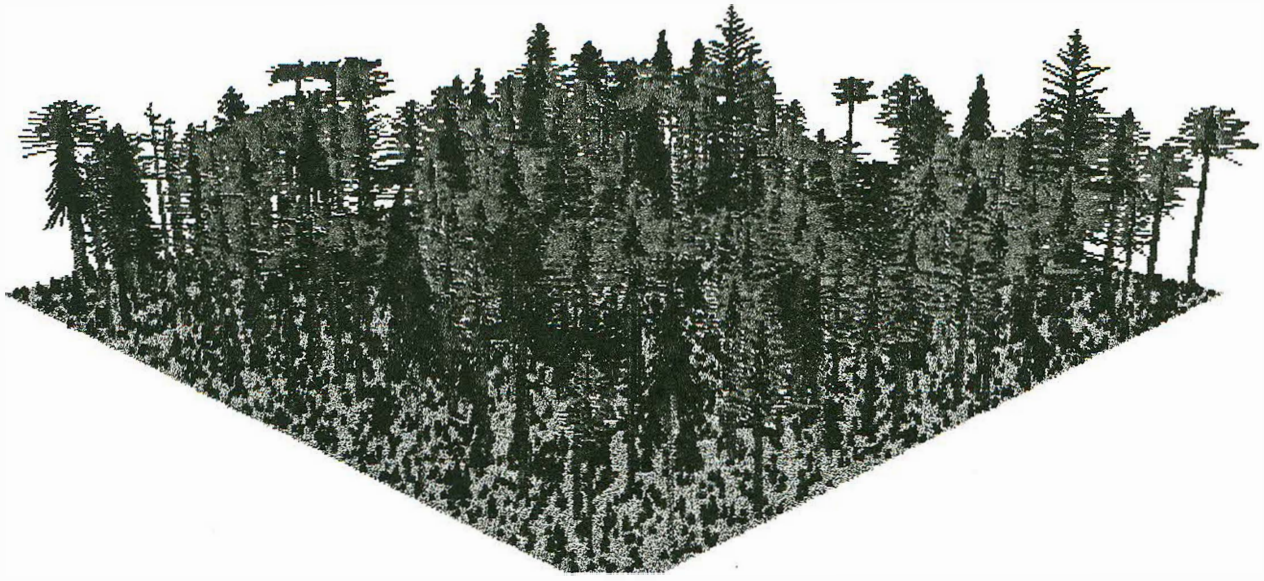
Table 3. FVS stand summaries before and 20 years later without and with treatment.

With Treatment

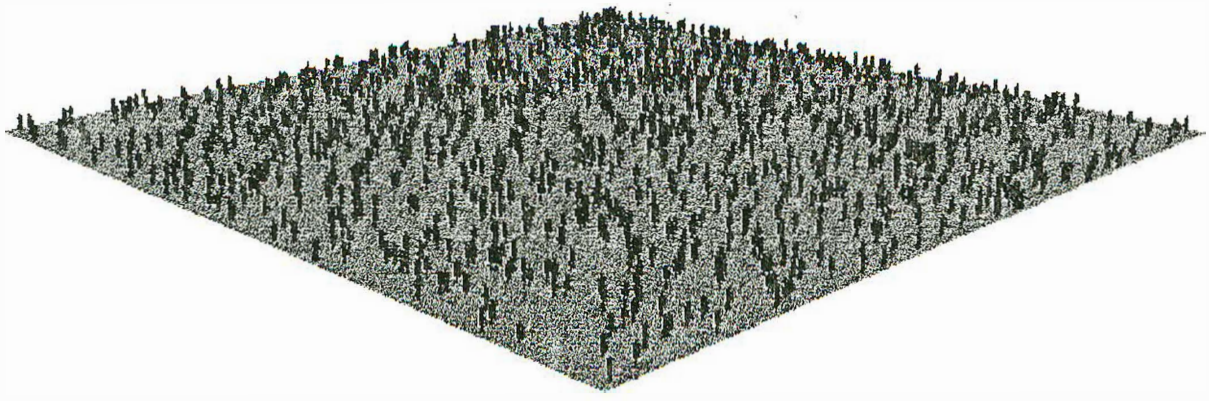
LOCATION	SUMMARY BEFORE TREATMENT						SIMULATED SUMMARY 20 YEARS AFTER TREATMENT						
	TPA	BA1"+	QMD	BRISK	% TPA w/ DM	MEAN DMI	TREATMENT	TPA	BA1"+	QMD	BRISK	% TPA w/ DM	MEAN DMI
110143-0001	6166	102	1.7	3	2 (19)	3.9	PF	1192	1	0.3	1	0 (0)	0
110143-0072	2509	162	3.4	3	25 (99)	3.3	PF	1192	3	0.7	1	0 (0)	0
110143-0001	6166	102	1.7	3	8 (19)	3.9	CC	4664	72	1.7	1	0 (0)	0
110143-0072	2509	162	3.4	3	14 (99)	3.3	CC	1440	58	2.7	1	0 (0)	0
110143-0036	2198	179	3.9	1	8 (22)	1.1	CT-RLP	1327	57	2.8	1	4 (4)	2.1
110144-0098	1594	120	3.7	3	14 (29)	2.9	CT-RLP	829	17	1.9	1	0 (0)	0
110142-0064	4436	182	2.7	3	0 (0)	0.0	CT-SAN	3283	80	2.1	1	0 (0)	0
110165-0025	1145	186	5.5	3	32 (58)	2.1	CT-SAN	296	15	3.0	1	0 (0)	0
110142-0023	6532	125	1.9	3	1 (8)	4.0	OR	5558	104	1.8	1	0 (0)	0
110165-0054	3363	139	2.8	1	8 (49)	2.6	OR	2335	58	2.1	1	5 (5)	4.2
110141-0002	2321	190	3.9	1	0 (0)	0.0	GS-LP	879	116	4.9	1	0 (0)	0
110142-0064	4436	182	2.7	3	0 (0)	0.0	GS-LP	3793	133	2.5	?	0 (0)	0
110141-0002	2321	190	3.9	1	0 (0)	0.0	SW-LP	308	2	1.2	1	0 (0)	0
110143-0069	3218	172	3.1	3	10 (43)	2.5	SW-LP	1143	66	3.3	1	7 (7)	2.1
110143-0001	6166	102	1.7	3	2 (19)	3.9	SW-R5	5135	90	1.8	1	0 (0)	0
110143-0072	2509	162	3.4	3	25 (99)	3.3	SW-R5	1037	45	2.8	1	0 (0)	0

APPENDIX B.
Figures 1-8.

Figure 1. SVS Projection - Stand 110143-0001 before and 20 yrs. after treatment with prescribed fire.

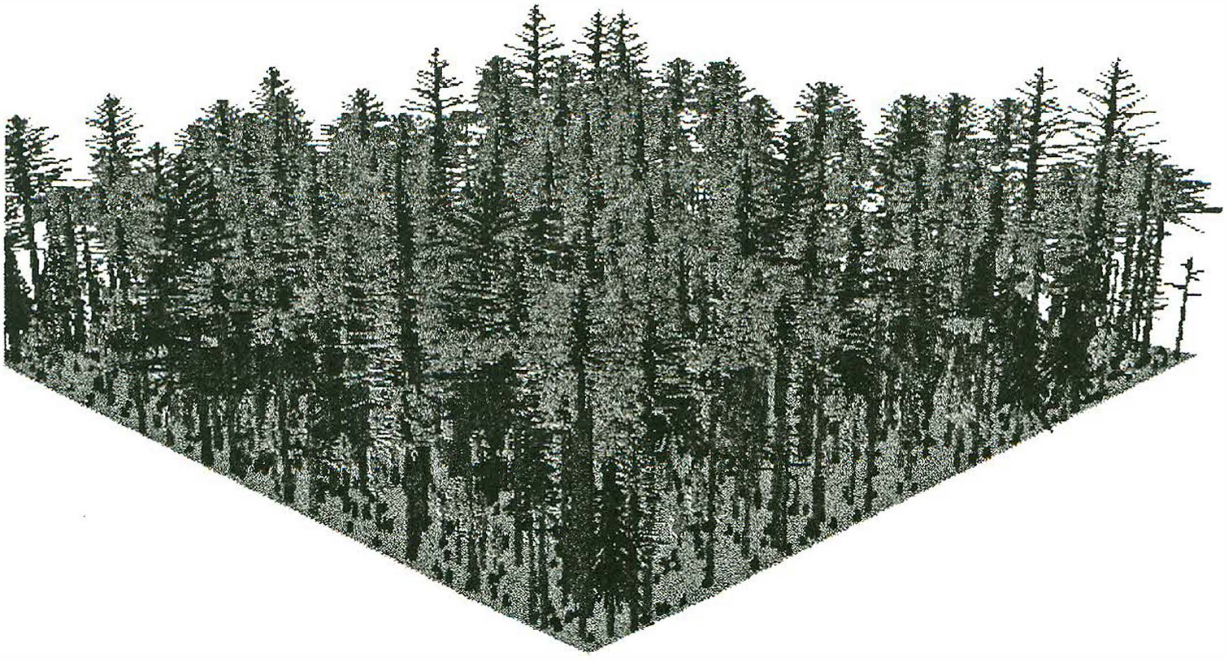


Before treatment with prescribed burn.

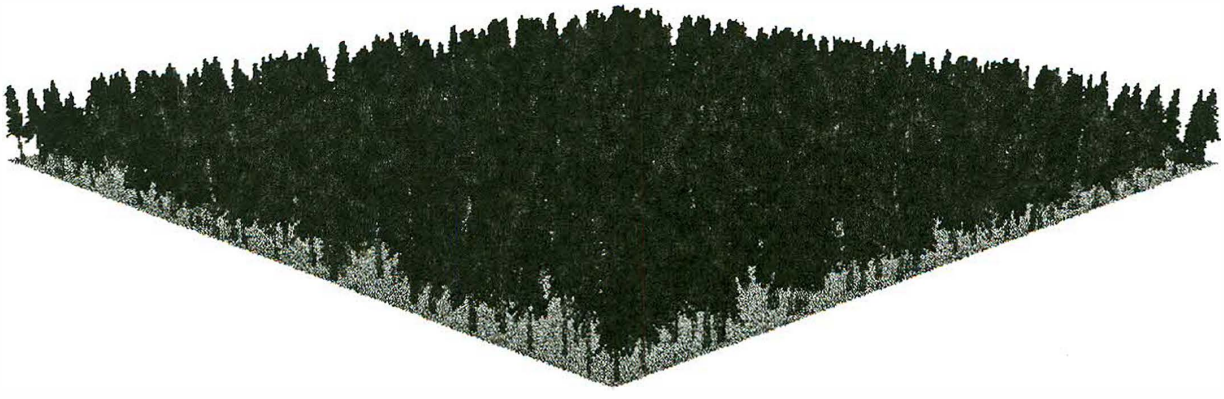


20 yrs. after treatment with prescribed burn.

Figure 2. SVS Projection - Stand 110143-0072 before and 20 yrs. after treatment with clearcutting.

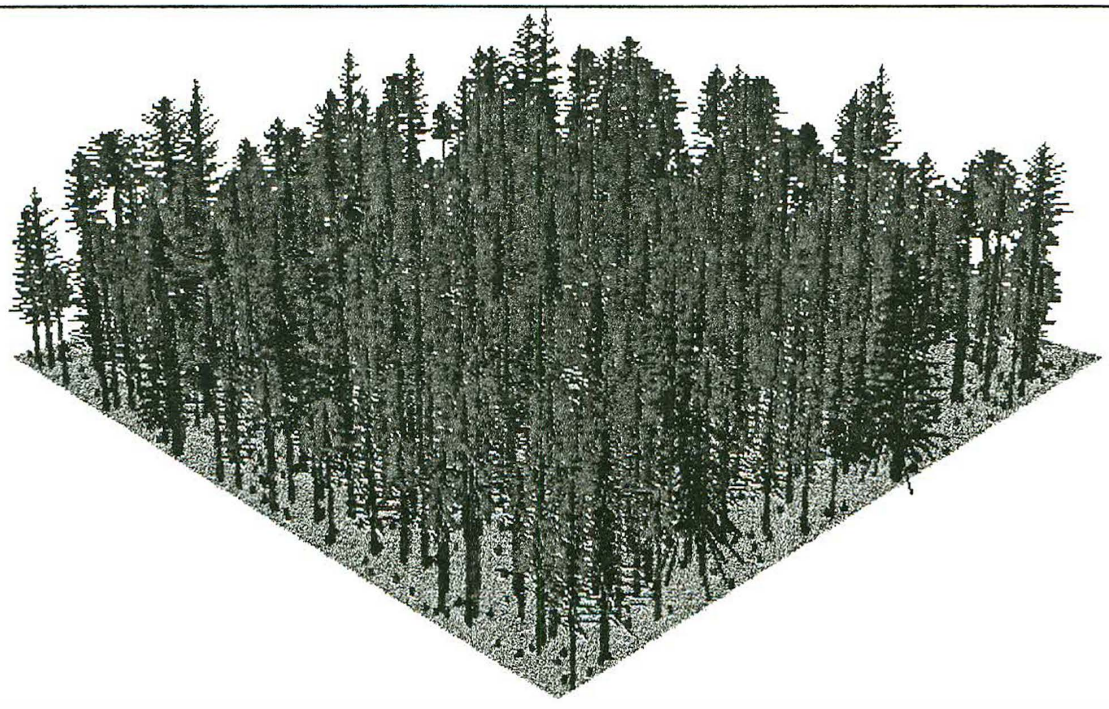


Before treatment with clearcutting.

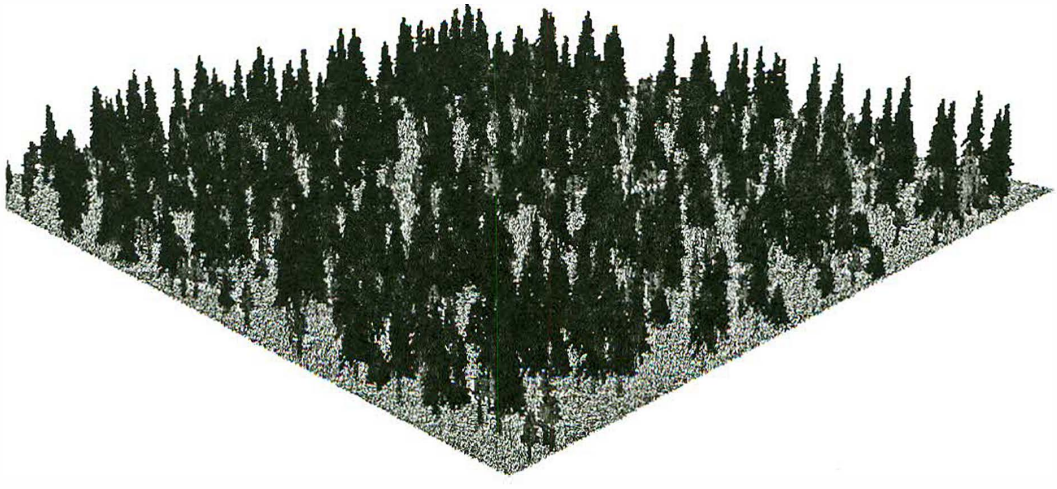


20 yrs. after treatment with clearcutting.

Figure 3. SVS Projection - Stand 110144-0098 before and 20 yrs. after treatment with commercial thinning.

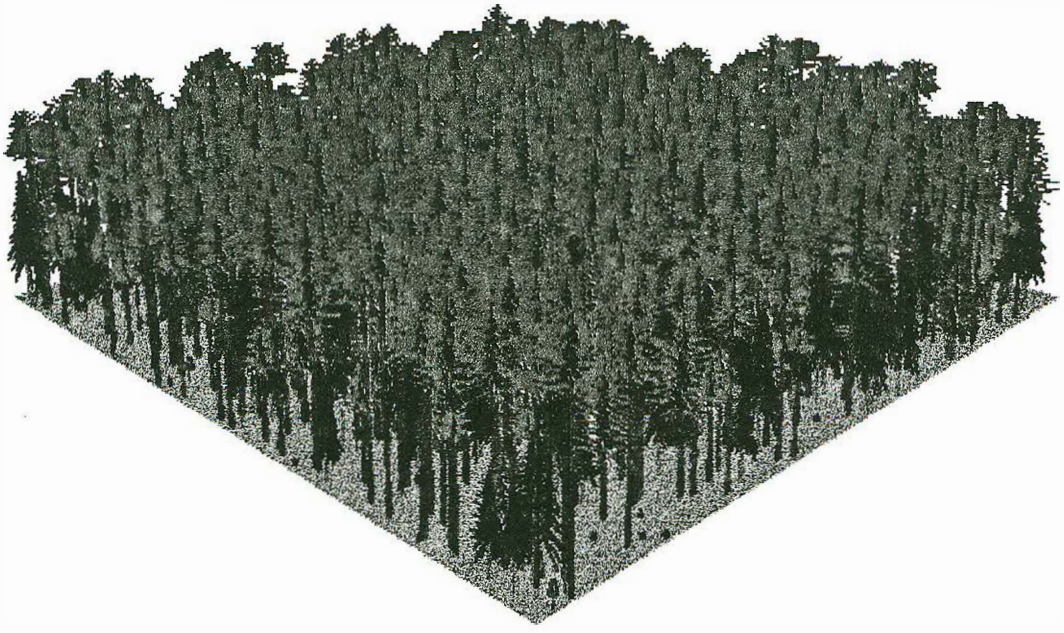


Before treatment with commercial thinning.

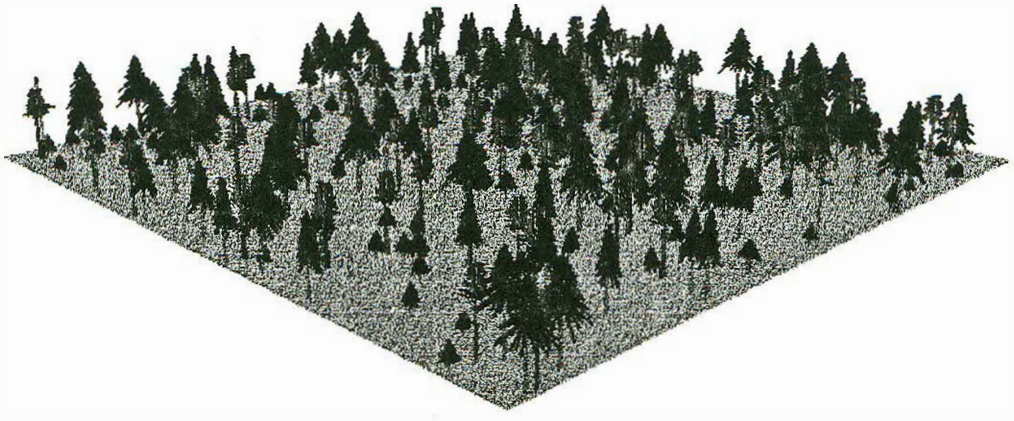


20 yrs. after treatment with commercial thinning.

Figure 4. SVS Projection - Stand 110165-0025 before and 20 yrs. after treatment with commercial thinning and sanitation.

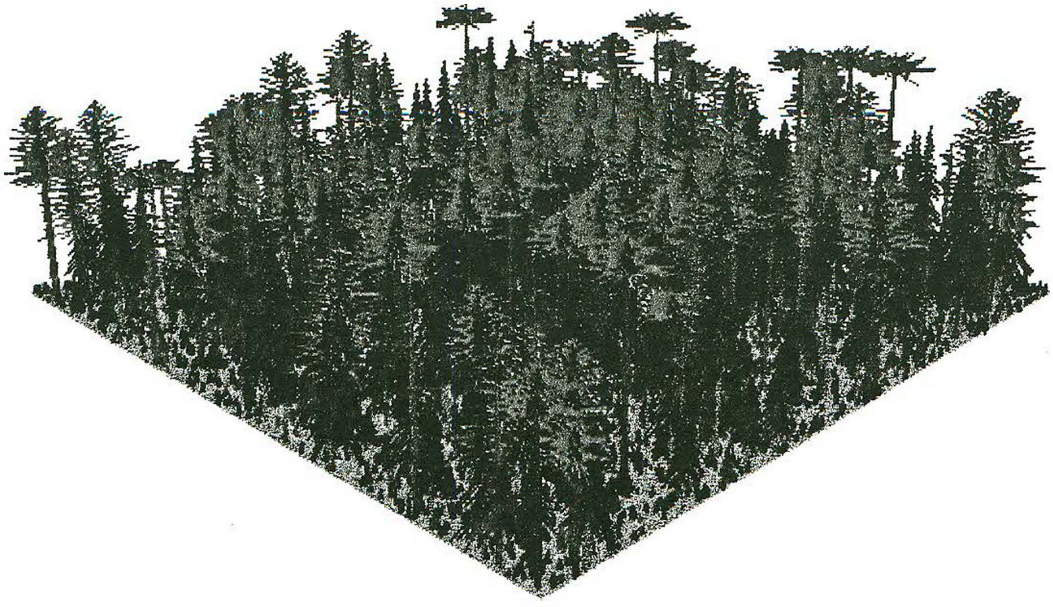


Before treatment with commercial thinning and sanitation.

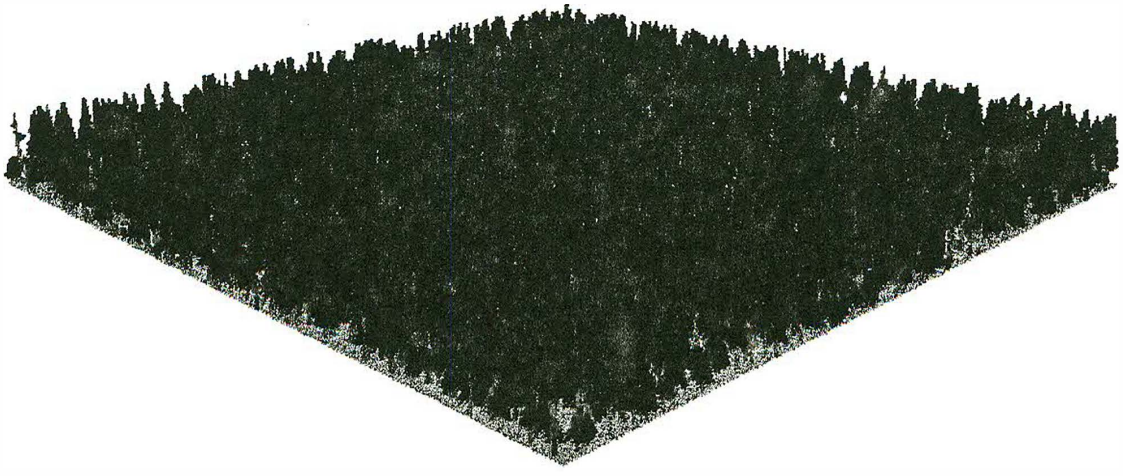


20 yrs. after treatment with commercial thinning and sanitation.

Figure 5. SVS Projection - Stand 110142 - 0023 before and 20 yrs. after treatment with overstory removal.

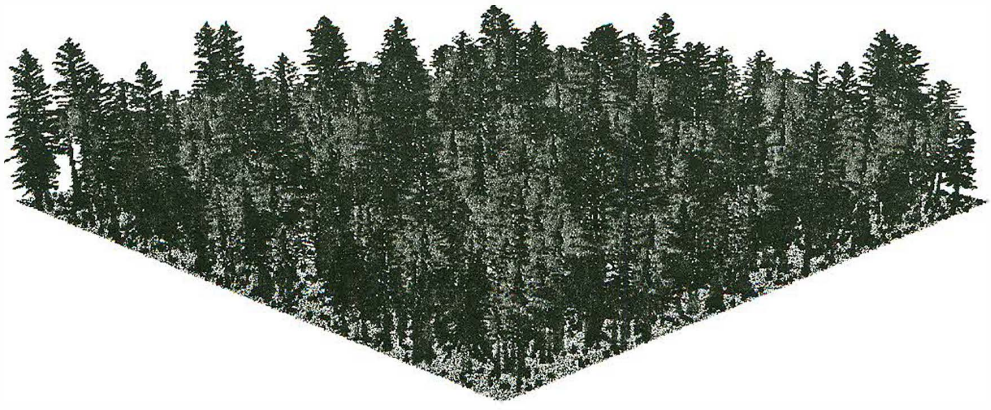


Before treatment with overstory removal.

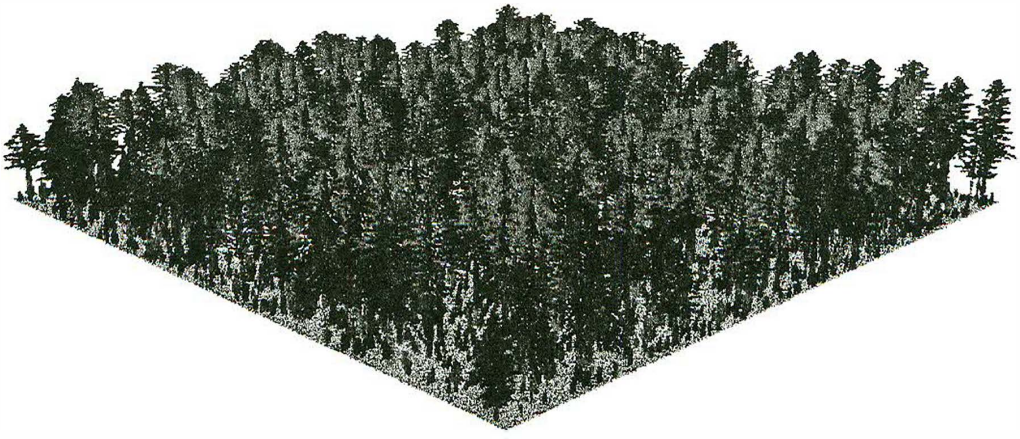


20 yrs. after treatment with overstory removal.

Figure 6. SVS Projection - Stand 110142 - 0064 before and 20 yrs. after treatment with group selection.

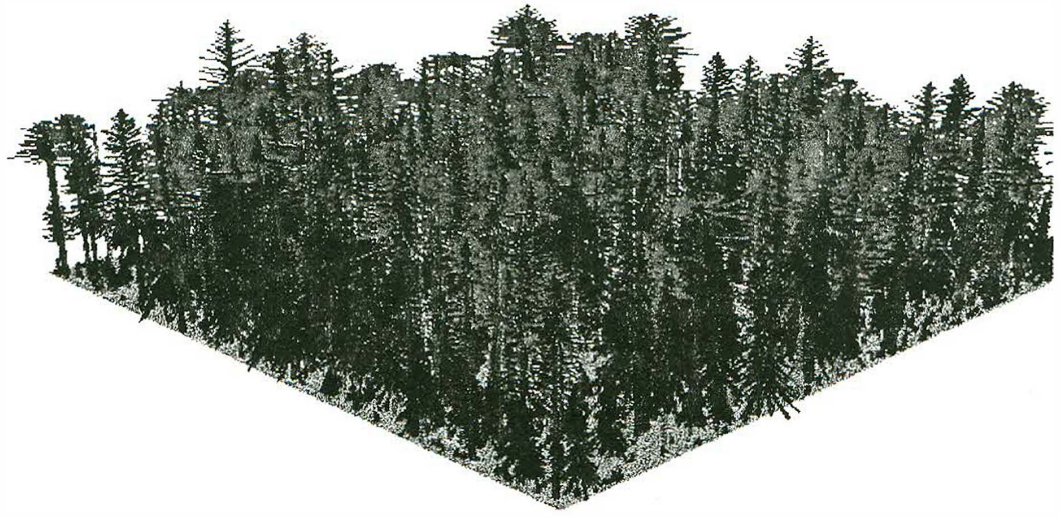


Before treatment with group selection.

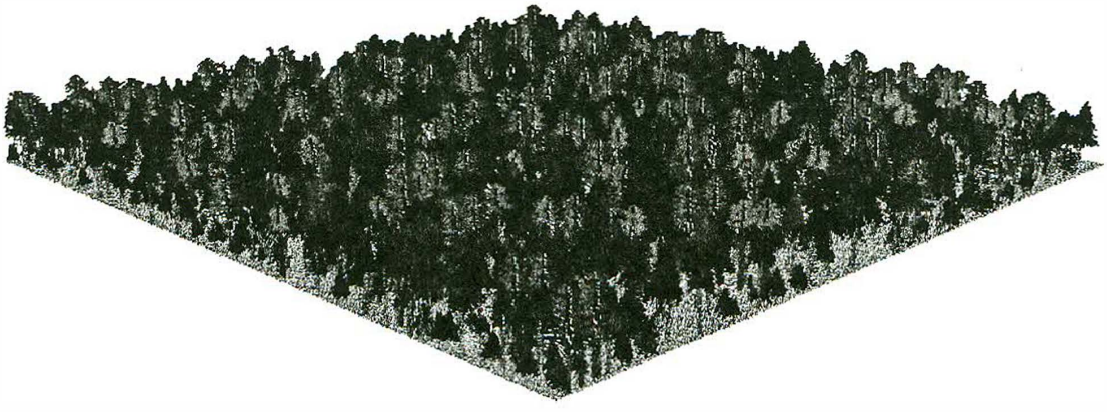


20 yrs. after treatment with group selection.

Figure 7. SVS Projection - Stand 110143 -0069 before and 20 yrs. after treatment with shelterwood.

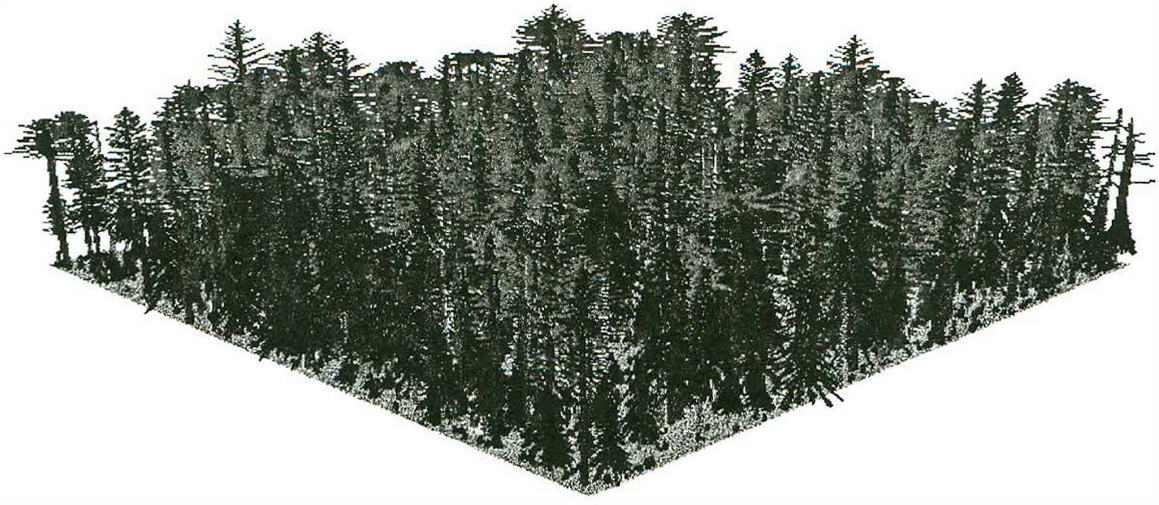


Before treatment with shelterwood.

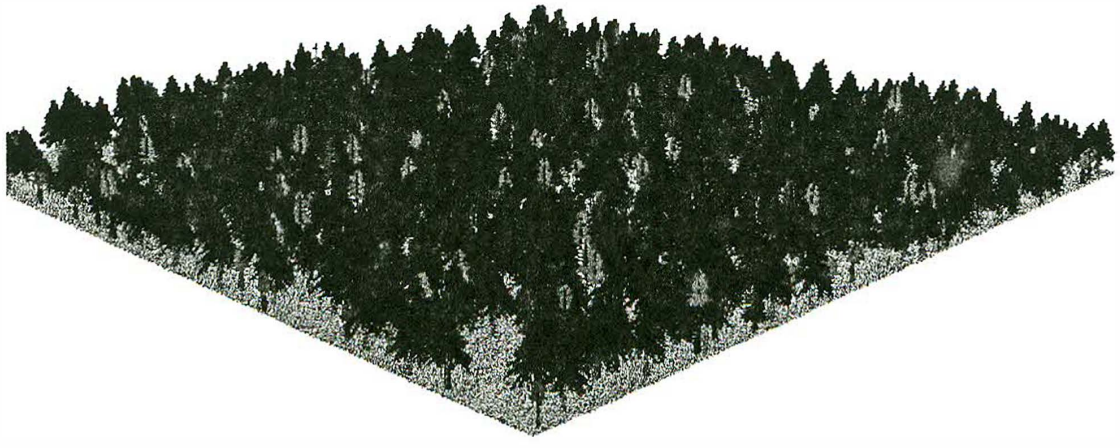


20 yrs. after treatment with shelterwood.

Figure 8. SVS Projection - Stand 110143 - 0072 before and 20 yrs. after treatment with shelterwood and harvest within 5 years.



Before treatment with shelterwood.



20 yrs. after treatment with shelterwood and harvest within 5 yrs.